BLIP Solar PV System Application

BL-IP, BU MMS
Q1 2012

Overview

- **Solar PV Energy may achieve grid parity before 2015**
  - Prices of the modules have plummeted from $3.50/watt in 2008 to $1.43/watt today (GTM Research)
  - Fuel prices are consistently increasing since 2008
  - Solar Electric Energy demand has grown by an average 30% per annum to 40GW over the past 20 years against a backdrop of rapidly declining costs and prices.
- **New Safety regulations**
  - Arc detection become mandatory in USA (2011) - Regulation **NEC 690.11** Arc-Fault Circuit Protection requires any PV system with DC circuit operating at 80V or greater need to be protected by Arc Fault Circuit Interrupter
  - Firefighter Association in Germany: Requires active control switch for fire-fighter to shut-off solar panels in case of fire
- **Green Energy Benefits & Awareness**
  - Struggling with a continuing nuclear crisis and strains on its power supplies, Japan is thinking of requiring that all new buildings, including homes, come equipped with rooftop solar panels by 2030, according to a recent Nikkei newspaper report.

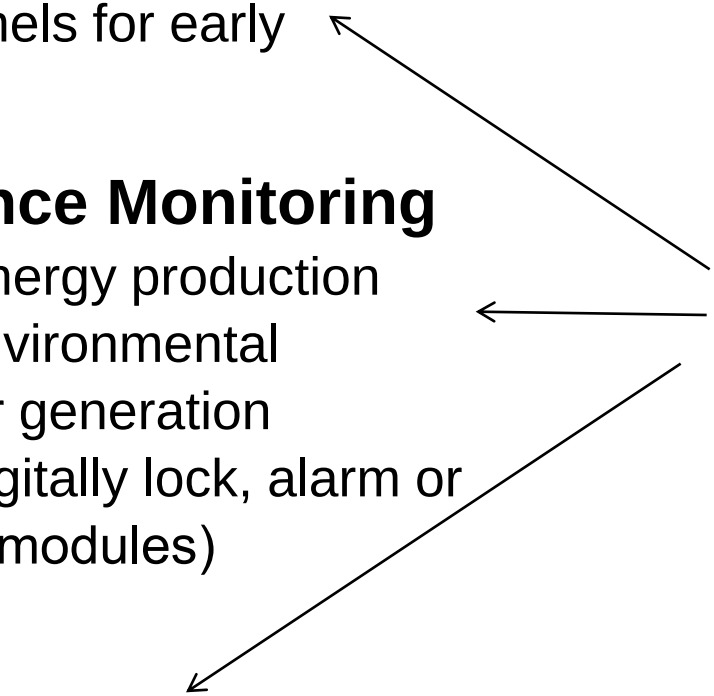
Types of Solar Systems

DC-off grid | residential | utility

off-line	domestic	commercial	power plant
<2kW	<10kW	10kW-2MW	>>MW
off-grid	grid connected @ demand side		supply side
w/ battery	w/ and w/o battery		

Factors driving electronics in Solar Panels

- **Maintenance**
  - Isolating faulty panels for early replacement
- **System Performance Monitoring**
  - Accurate view of energy production
  - Monitor effect of environmental conditions in power generation
  - Theft protection (digitally lock, alarm or 'immobilize' stolen modules)
- **Safety**
  - Fire-fighter Safety
  - Arc Fault Detection

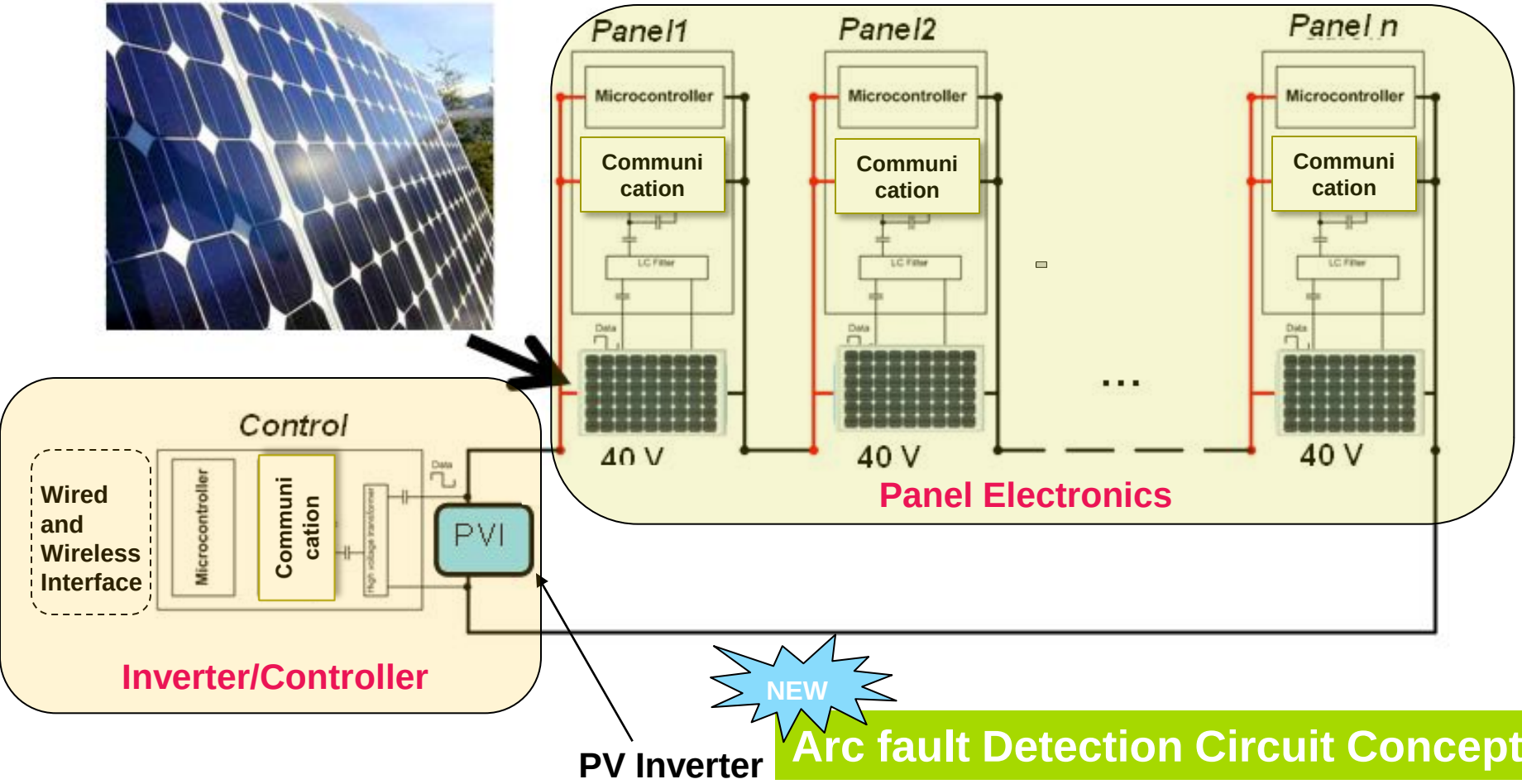


NXP Solar Panel Controller and Active Fire Safety Switch Reference Design

Separate solution

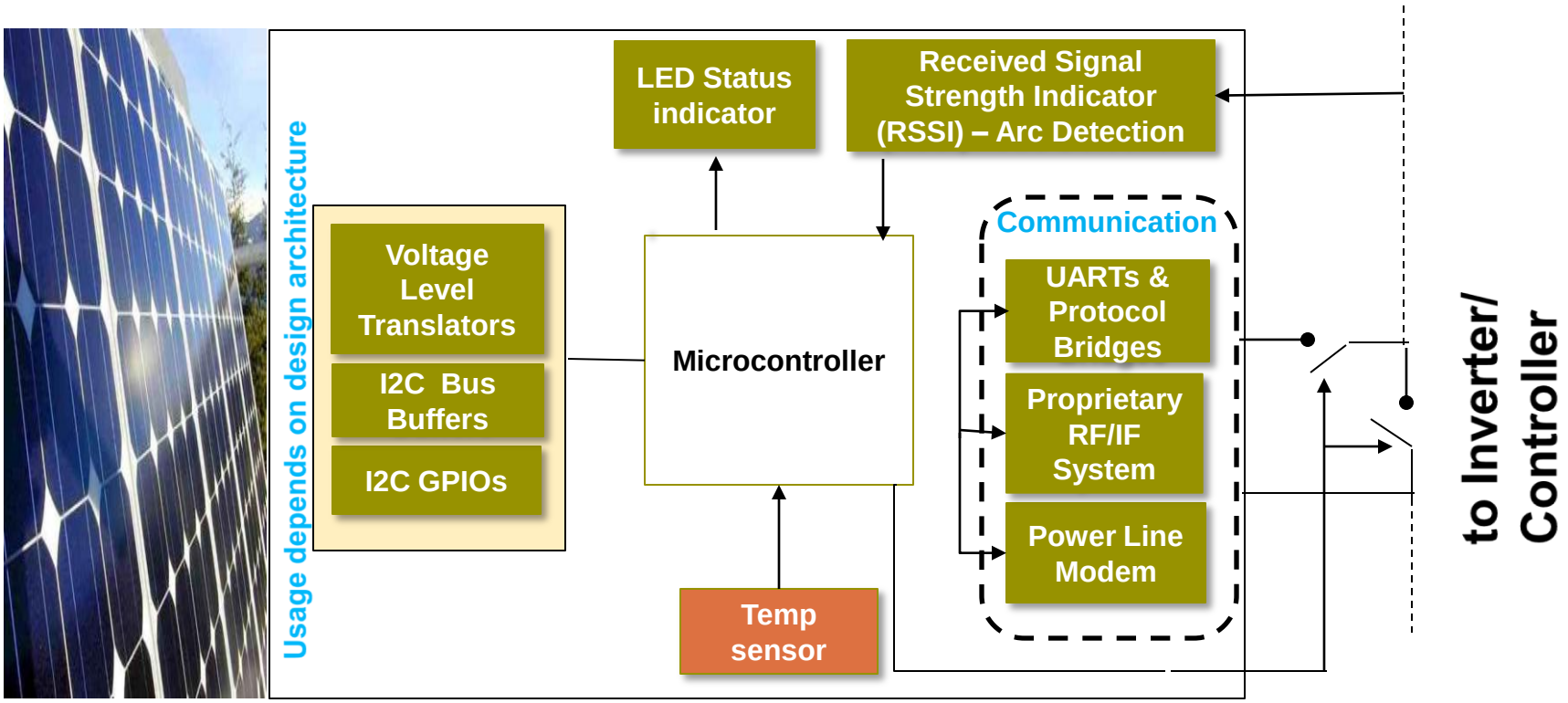
Solar PV System
Block Diagram

NEW **Solar Panel Monitoring Reference Design**



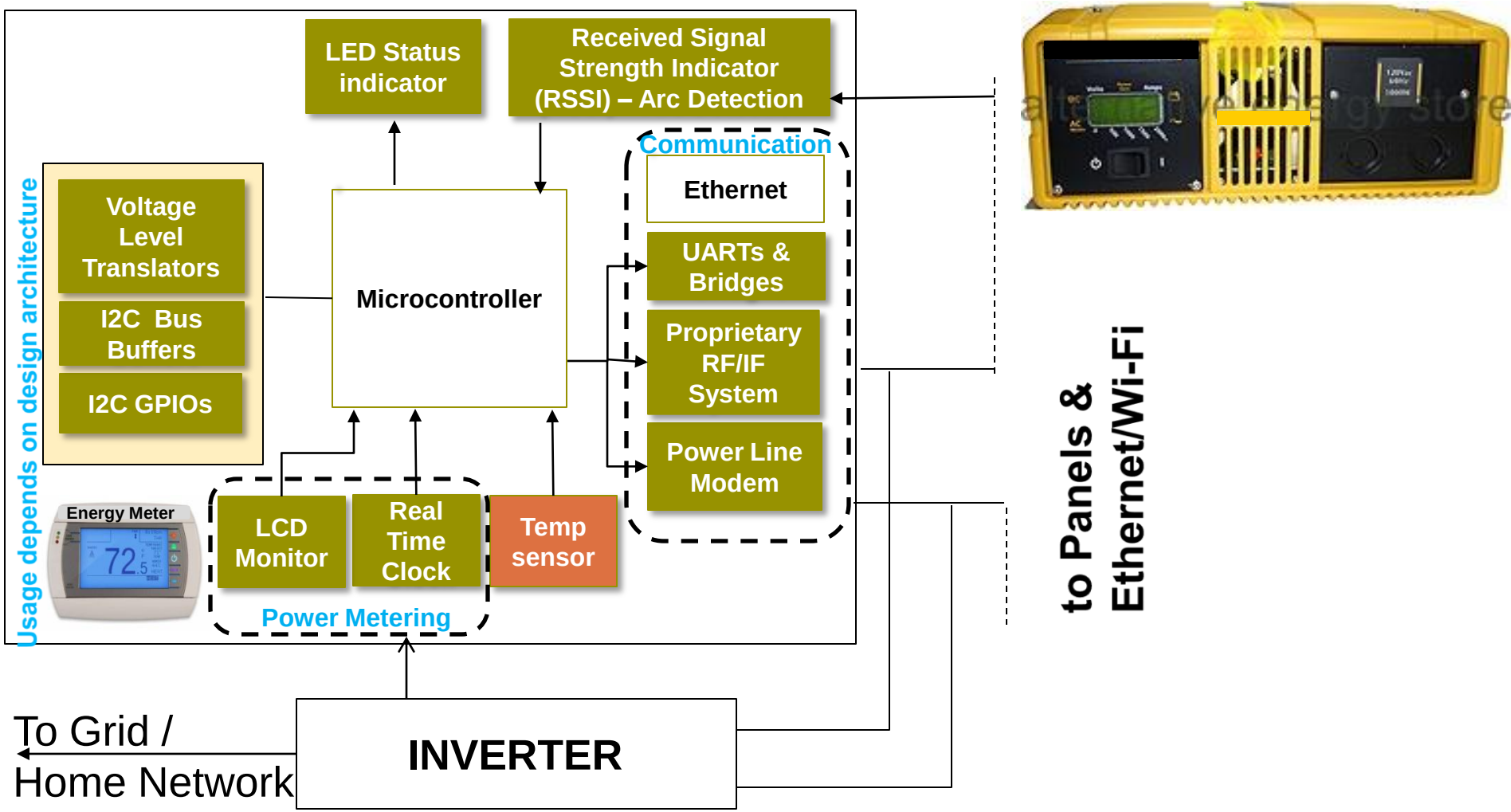
NEW **Arc fault Detection Circuit Concept**

Solar PV Panel
Block Diagram



Solar Inverter / Charge Controller

Block Diagram



Power Line Modem

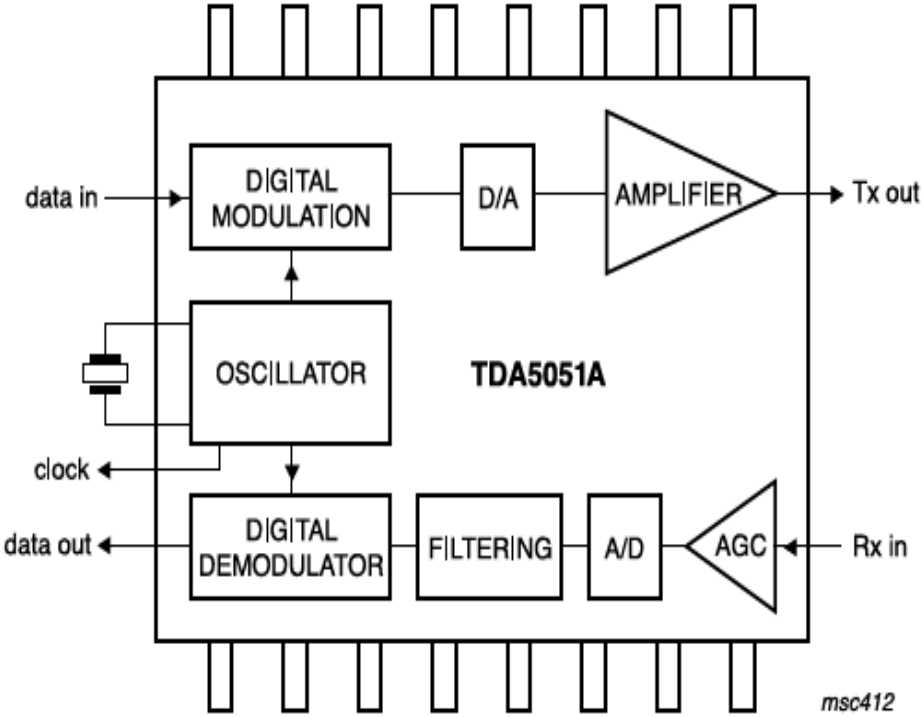
TDA5051A Power Line Modem

Features:

- Low cost solution and easy assembly with SO16 plastic package
- ASK Power Line Modem operating up to 1200 bps
- 5V supply voltage
- Carrier frequency set by clock from micro controller or on-chip oscillator
- Automatic gain control of receiver input & power overload protection transmitter output
- 8-bit A/D and narrow digital filtering
- Easy compliance with EN50065-1 with simple power line coupling networks

Benefits:

- Low cost digital PL modem solution
- NXP software support
- Robust solution with zero cross detection and redundancy protocol



In Production

UARTs & Bridges

I2C/SPI/UART Protocol Bridges Value Proposition

- **Where Used?**
  - New generation of interface solutions for managing communication among various bus interfaces
  - The purpose is to overcome the limitations of the host bus interface to the peripherals
- **Why Used?**
  - Greater design flexibility
  - Ability to retain original design investment
  - Faster time to market
  - Link legacy and new systems and vice versa
- **Why NXP Bridges?**
  - Wide portfolio of I2C/SPI/UART Bridges to choose from.

I²C/SPI-to-UART Bridges

Part #	UART	FIFO	SPI	GPIO
SC16IS740	1	64	4Mbps	-
SC16IS750	1	64	4Mbps	8
SC16IS752	2	64	15Mbps	8
SC16IS760	1	64	15Mbps	8
SC16IS762	2	64	15Mbps	8

UART-to-I²C Bridge

Part #	UART	I²C	GPIO	CLK
SC18IM700	460.8Kbps	400KHz	8	Int

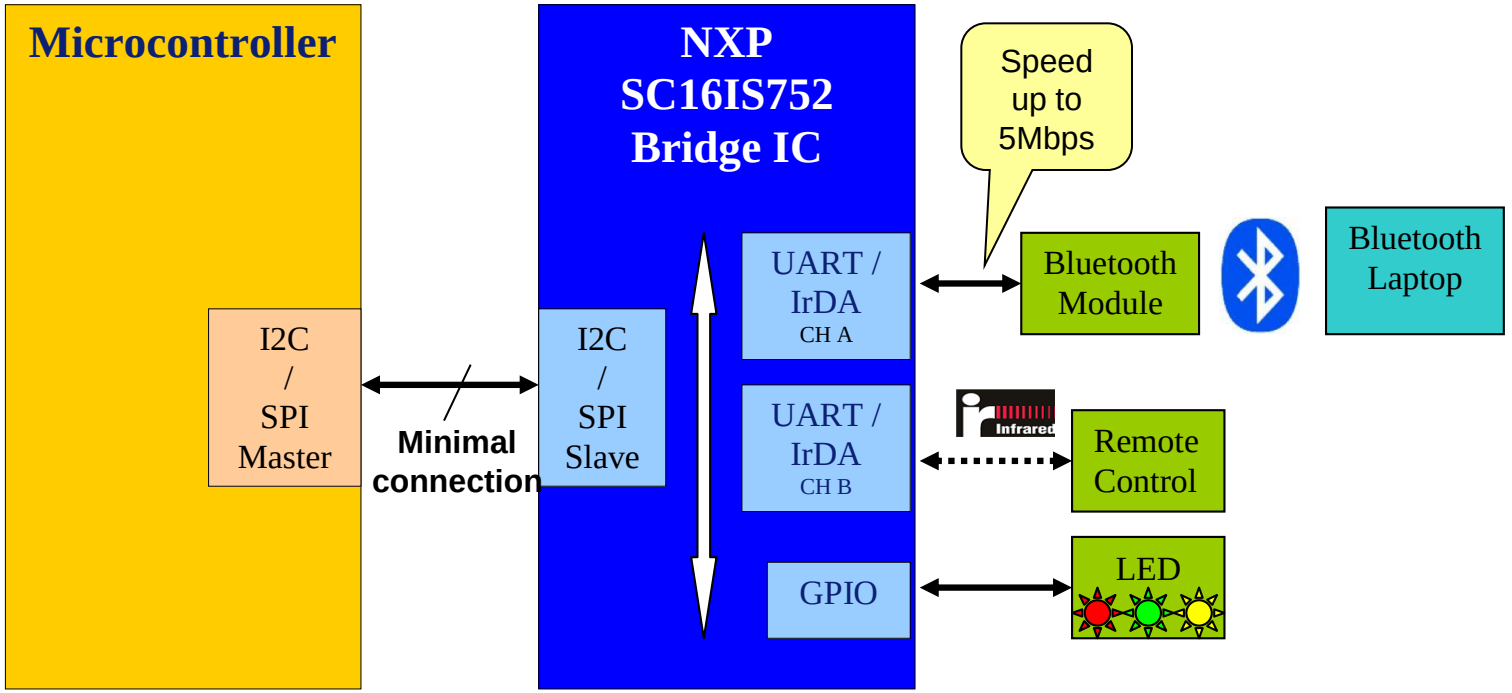
I²C-to-SPI Bridges

Part #	SPI	I²C	GPIO	CLK
SC18IS602B	1.8Mbps	400kHz	4	Int

SPI-to-I²C Bridges

Part #	SPI	I²C	GPIO	CLK
SC18IS600	1Mbps	400kHz	4	Int

SC16IS75x/76x : I²C/SPI to UART Bridge

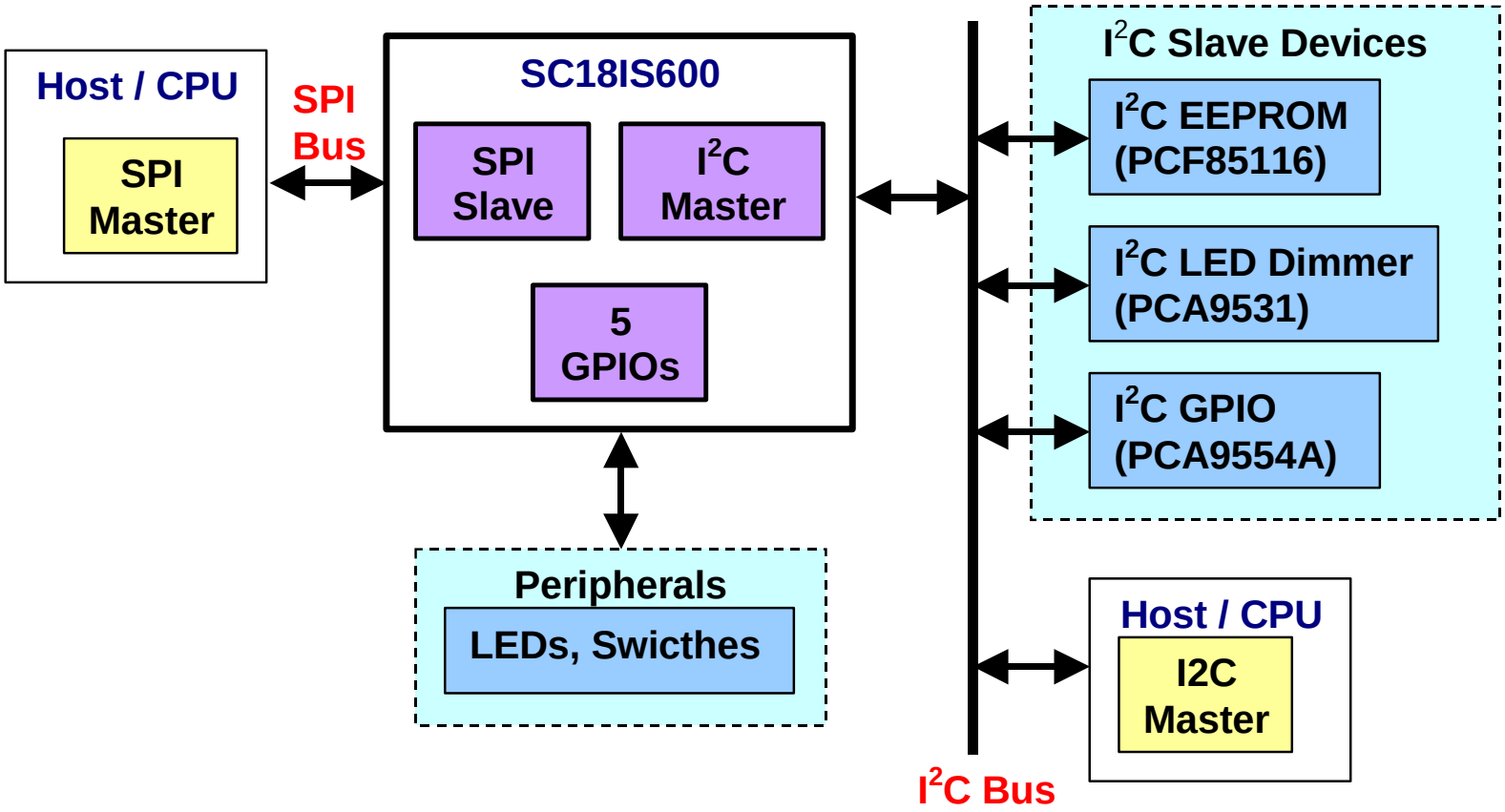


Enhance your connectivity to fully-featured serial interfaces: without the hassle!

Advantages:
-2.5V or 3.3V Operation
-64-byte FIFO
-Baud rate up to 5Mbps
-Auto HW and SW flow controls
-Built-in IrDA SIR
-Up to 8 programmable GPIO
-And more

In Production

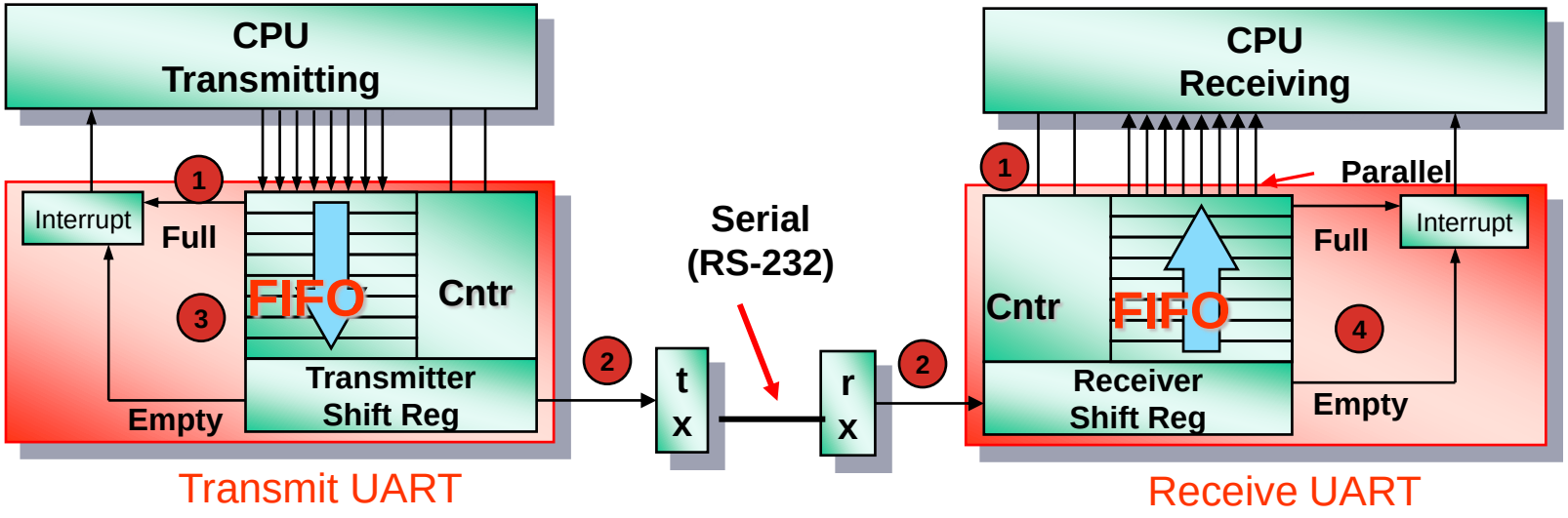
SC18IS600: SPI-to-I2C



In Production

UART's Value Proposition

- **Why used?**
  - Transmits and receives data transfer between processor and communication channel
  - Checks communication error and relieves processor from the task of managing communication errors
- **Where used?**
  - Communication channels in patient monitoring equipment
- **Why NXP UARTs?**
  - Established committed long-term supplier
  - Broad portfolio in the industry
  - Number #1 supplier for Industrial UARTs



UARTs – Quick-Pick

UARTs

Single Channel

- <16-byte FIFO
  - SCC2691
- 16-byte FIFO
  - SC16C550B
  - SC28L91
- 32-byte FIFO
  - SC16C650B
- 64-byte FIFO
  - SC16C750B
  - SC16C751B
- 128-byte FIFO
  - SC16C850
  - SC16C850L (1.8V)
  - SC16C850SL (1.8V)
- 256-byte FIFO
  - SC28L201

Dual Channel

- <16-byte FIFO
  - SCC2681
  - SCC68681
  - SCC2692
  - SCC68692
  - SC26C92
- 16-byte FIFO
  - SC68C2550B
  - SC16C2550B
  - SC16C2552B
  - SC28L92
- 32-byte FIFO
  - SC68C652B
- 64-byte FIFO
  - SC68C752B
  - SC16C752B
- 128-byte FIFO
  - SC16C852
  - SC16C852V (VLIO)
  - SC16C852SV(VLIO)
- 256-byte FIFO
  - SC28L202

Quad Channel

- 16-byte FIFO
  - SC16C554B
  - SC28L194
- 64-byte FIFO
  - SC16C654B
  - SC16C754B

Octal Channel

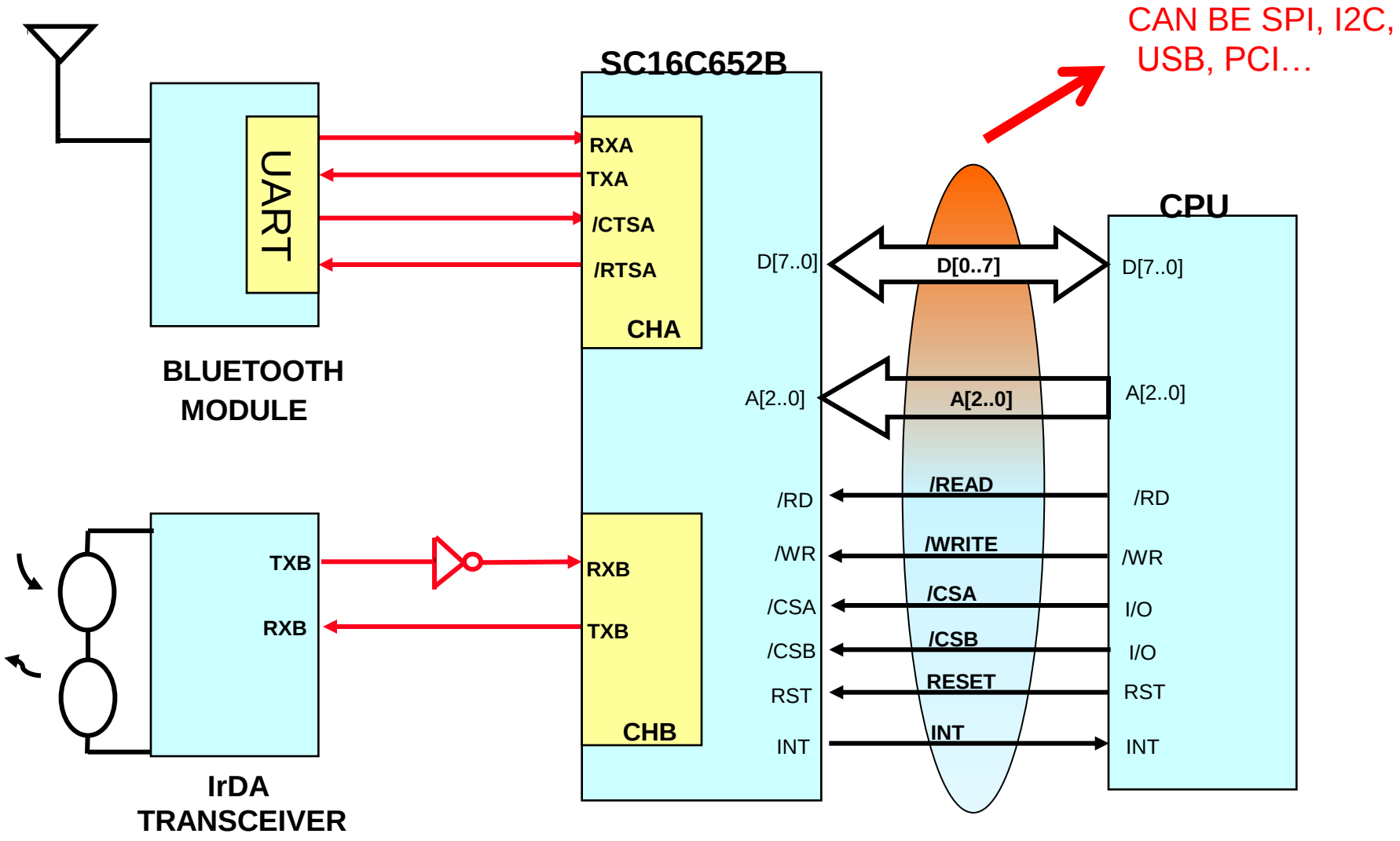
- 16-byte FIFO
  - SC28L198

----16C UARTs

----Industrial UARTs

---- New UARTs

UART APPLICATION DIAGRAM



SC16C85xx: New 1.8V – 3.3V UARTs

- Single- and dual-channel UART
- Intel/Motorola and VLIO interface
- Sleep Mode / Low Power mode
- up to 5Mbps
- 128 bytes Tx / Rx FIFOs
- Automatic RS485
- IrDA version 1.0
- Independent UART Tx and Rx enable/disable
- Ultra small: TFBGA

Part Number	CH	Host Interface	V_{CC}	TFBGA (3.5x3.5)	HVQFN (5x5)	LQFP (7X7)
SC16C850L	1	Intel / Motorola	1.8 V	√	√	TBD
SC16C850V	1	VLIO	1.8 V	TBD	√	
SC16C852L	2	Intel / Motorola	1.8 V	TBD	√	√
SC16C852V	2	VLIO	1.8 V	√	√	TBD

SC16C850IBS/Q900

- UART with 16-mode or 68-mode parallel bus interface; -40°C to +85°C; HVQFN32; AEC-Q100 compliant automotive qualification

In Production

SC16C85xxS: New 1.8V – 3.3V UARTs

- Single- and dual-channel UART
- Intel/Motorola and VLIO interface
- Sleep Mode / Low Power mode
- Programmable Sampling Rates up to 20Mbps
- 128 bytes Tx / Rx FIFOs
- Automatic RS485
- IrDA version 1.0
- Independent UART Tx and Rx enable/disable
- Ultra small: TFBGA

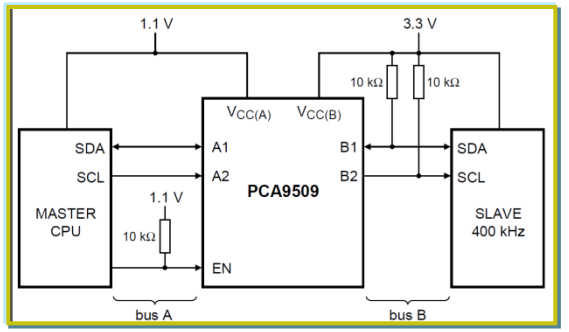
Part Number	CH	Host Interface	V_{CC}	TFBGA (3.5x3.5)	HVQFN (5x5)	LQFP (7X7)
SC16C850SL	1	Intel / Motorola	1.8 V	√	√	TBD
SC16C850SV	1	VLIO	1.8 V	TBD	√	
SC16C852SL	2	Intel / Motorola	1.8 V	√	√	√
SC16C852SV	2	VLIO	1.8 V	√	√	TBD

In Production

I2C Bus Buffers & Level translators

Active Voltage Translator Buffer

- **Value Proposition**
  - Largest selection of active and passive level shifters to accommodate lowest processor voltage (<0.8V) and highest peripheral voltage (>5.5V)
  - Guaranteed compliance to I²C
  - Market leader in I²C Level translator



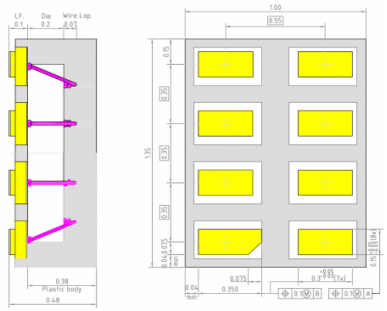
Device	Description	Normal I/O	Static Level Offset I/O	Accelerator	Idle Stop Detect for Hotswap	Interrupt	ESD (HBM)
PCA9507	2.7V-to-5.5V Level Shifter	A Side	B Side	× (A-Side)			5KV
PCA9508	0.9V-to-5.5V Level Shifter with Offset Free Hot-Swap	A Side	B Side		×		6KV
PCA9509/A	0.8V-to-5.5V Level Shifter	B Side	A Side				2KV
PCA9515A	3.3V / 5.0V I²C-Bus Repeater		A & B Sides				2KV
PCA9516A	5-Channel I²C Bus Hub		A & B Sides				2KV
PCA9517A	0.9V-to-5.5V Level Shifter	A Side	B Side				5KV
PCA9518A	5-Channel I²C Bus Hub Expander		A & B Sides				2KV
PCA9519	1.1V-to-5.5V Quad Level Shifter	B Side	A Side				2KV
PCA9527	3.0V-to-5.5V Level Shifter	A Side	B Side	× (A-Side)		×	8KV

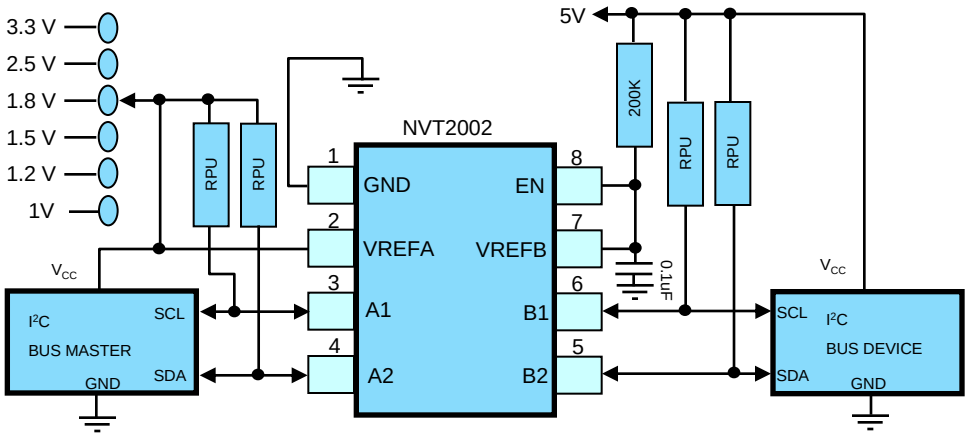
Low Power Passive Voltage Translators

# CH	New	OLD	Usage
1	NVT2001	--	Clock
2	NVT2002 PCA9306	GTL2002	I²C, I2S, SMbus
3	NVT2003*	--	I²C, server
4	NVT2004	--	SPI
6	NVT2006	--	I²C + SPI
8	NVT2008	GTL2003	Digital RGB
10	NVT2010	GTL2010	Data Bus
22	--	GTL2000	Address + Data

SOT1089
extremely thin
small outline
package

(1.35 x 1 x 0.5 mm with
0.35mm pitch)





- NVT means “**N**XP **V**oltage **T**ranslator”
- Lowest standby current (5 uA)
- Widest supply range (from 1V to 5V)
- Bi-directional without the need for a direction pin
- I²C and DDC compliant
- Lock-up free operation for isolation when EN=LOW
- For new designs, we recommend the NVT family, but NXP will continue to support GTL2000/02/03/10 and PCA9306

*NVT2003 – sampling

Real Time Clocks

NXP Real Time Clock Families

Low power Family (PCF8563, PCF2123, PCF8523):

Main Features / Value Proposition:
- industry lowest power consumption of less than 100nA
- electronic tuning for temperature compensation, accuracy tuning and aging adjustment

NEW

Applications:
- low-power time-keeping applications
- low standby power applications

Extended temperature Family (PCA8565, PCA21125, PCA2129/Q900):

NEW

Main Features / Value Proposition:
- temperature range -40°C to 125°C
- AEC-Q100 qualified

Applications:
- time-keeping applications under harsh automotive and industrial conditions`

Highly accurate Family (*PCF2127A, PCF2129A)* :

Main Feature / Value Proposition:
- as low as +/- 3 ppm (+/- 0.26s/day) accuracy over a wide temperature range
- Integrated TCXO

Applications:
- Applications that requires an accurate process timing
- Time-keeping instruments with high precision
- e-meetering for electricity, water and gas

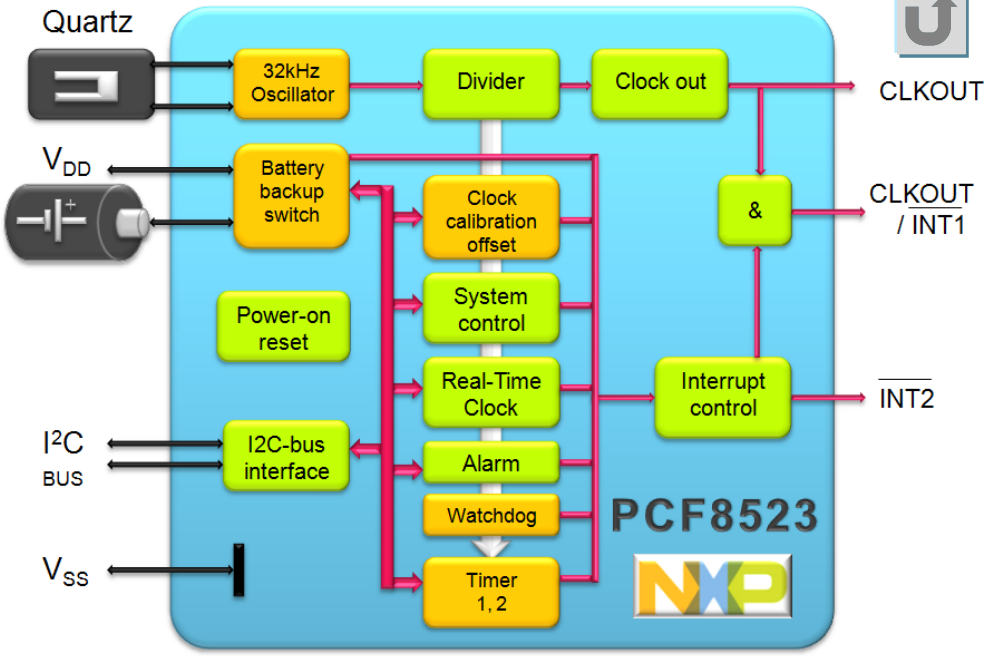
Real Time Clock Family

* The supply voltage range listed is for functional operation only. For data retention and time-keeping purposes, the minimum supply voltage is even lower (≤1.3V). Please consult the device datasheet for this specification.

Type	Function/Conditions	Features	Specialty	Packages
PCF8593	RTC/Calendar 2.5V* to 6V; -40° to +85°C	Existing Designs I²C (100KHz)	1/100s resolution 1µA@2V	DIP8; SO8
PCF8583	RTC/Calendar/RAM 2.5V* to 6V; -40° to +85°C	RTC + RAM I²C (100KHz)	240 Bytes RAM 2µA@1V	U (Die Only); DIP8; SO8; HVQFN20
PCF8563 /5	RTC/Calendar 1.8V* to 5.5V; -40° to +85°C	Lowest Power I²C (400KHz)	Ultra-low Power; 225nA@2V	U (Die Only); DIP8; SO8; TSSOP8; HVSON10
PCF8564A	RTC/Calendar 1.8V* to 5.5V; -40° to +85°C	for modules I²C (400KHz)	Ultra-low power; 225nA@2V Two integrated capacitors	U (Die Only); CX9 (Solder Bumps)
PCA8565	RTC/Calendar 1.8V* to 5.5V; -40° to +125°C	AEC Q100 Qualified I²C (400KHz)	0.6µA @ 2V	TSSOP8; HVSON10
PCF2123	RTC/Calendar 1.6V* to 5.5V; -40° to +85°C	Lowest Power SPI (6MHz)	Ultra-low Power, **100nA** @ **2V** With electronic tuning	U (Die Only); TSSOP14; HVQFN16
PCF8523	RTC/Calendar 1.6V* to 5.5V; -40° to +85°C	Lowest Power I²C (1MHz)	Ultra-low Power, 150nA@3V With electronic tuning	U (Die Only); SO8; TSSOP14; HVSON8
PCA21125	RTC/Calendar 1.6V* to 5.5V; -40° to +125°C	AEC Q100 Qualified SPI (6MHz)	0.82µA@2V	TSSOP14
PCF2127A	RTC/Calendar/RAM 1.8V* to 4.2V; -40° to +85°C	Very Accurate ±3ppm I²C (1MHz) / SPI	**Integrated TCXO** 0.5µA@2V; 512 Bytes RAM	SO20
PCF2129A	RTC/Calendar 1.8V* to 4.2V; -40° to +85°C	Very Accurate ±3ppm I²C (1MHz) / SPI	**Integrated TCXO** 0.5µA@2V	SO20
PCA8802	SmartCard RTC 1.6V* to 5.5V; -40° to +85°C	Wafer Chip Scale I²C (1MHz)	Ultra-low Power;130nA@3V	U (Wafer-level chip-size)

LOW Power RTCs

- Accurate time based on 32kHz quartz oscillator, electrical tuned
- Time from seconds ... Years
- Timer, Counter, Watchdog,
- Low power: **0.1µA** operating current
- SPI-bus (PCF2123), I2C-bus (PCF8

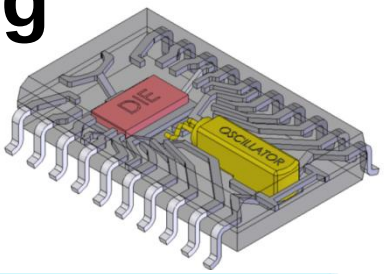


- Time keeping, accurate timing
- Digital Camera, still video
- GPS, mobile / cellular phones walky talky for fire fighters…
- Medical, home blood-pressure, diabetes
- Cut system power, by just running the RTC to wake-up the controller periodically

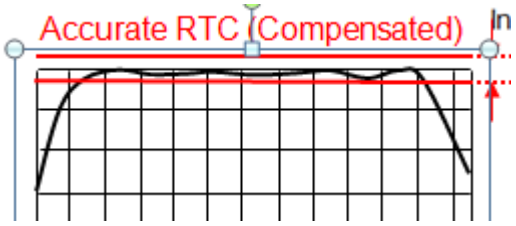
Applications:

Accurate RTC for ultra precision timing

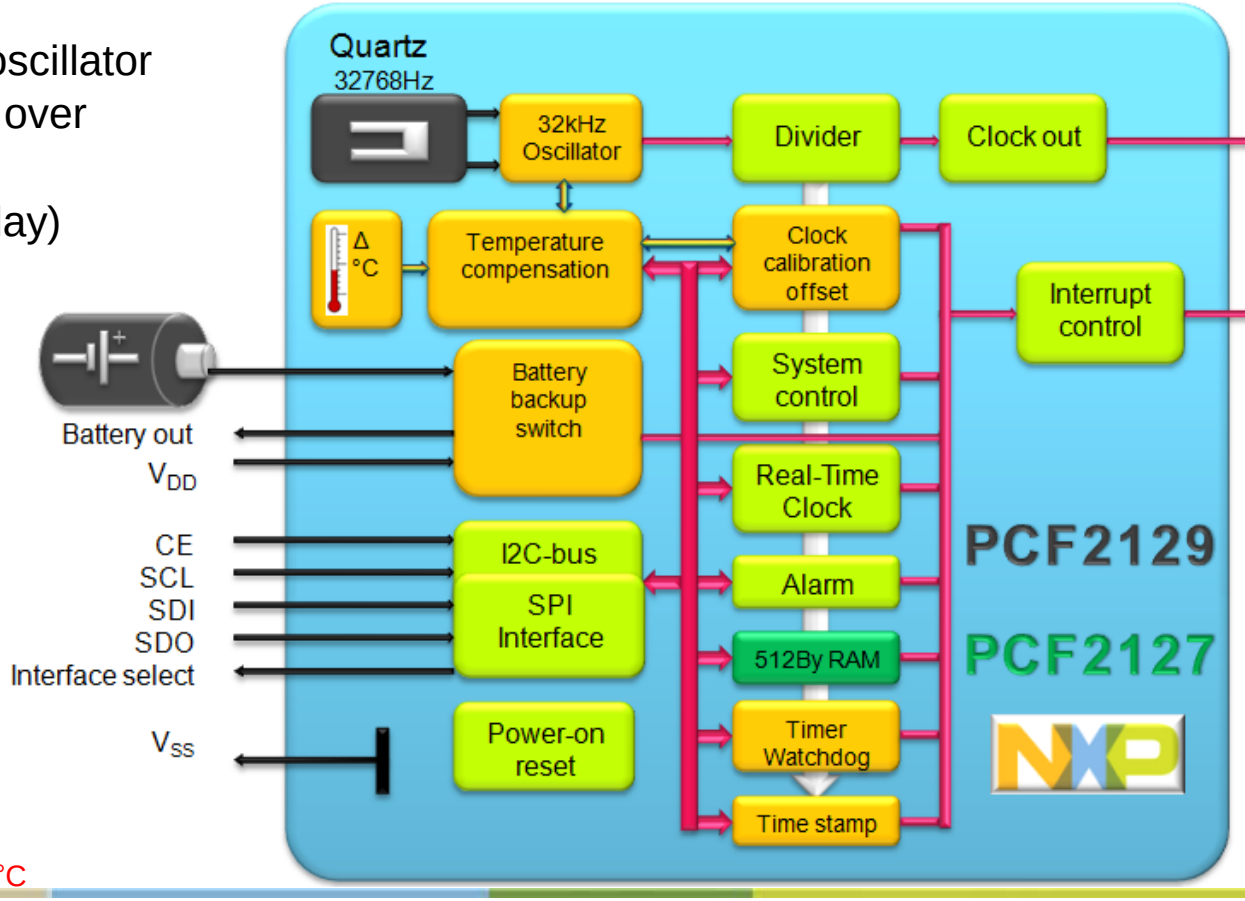
PCF2129T, PCF2127



- Integrated solution RTC and Quartz in one package
- Temperature compensated oscillator with high accuracy +/- 5ppm over extended temperature range (11ppm corresponds to 1s/day)
- Battery management
- Time stamp
- SO20 package
- Industrial grade,
- 512Byte RAM (2127)



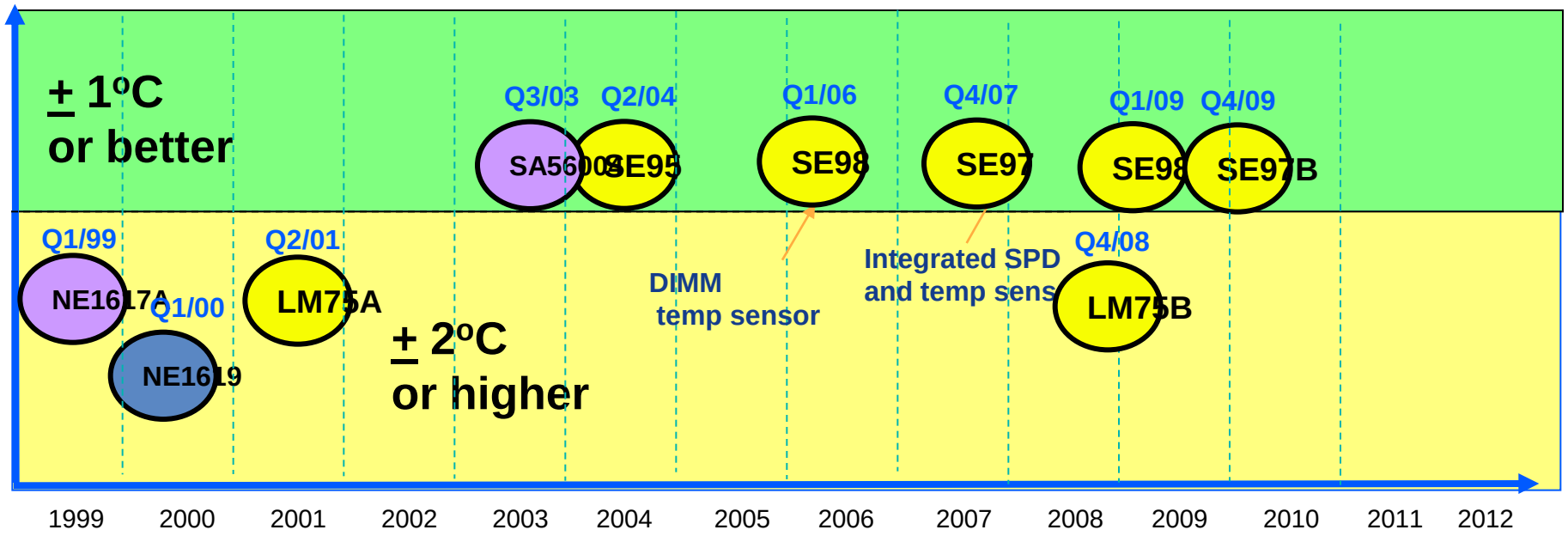
Typical Error: Only ±3ppm over -15°C to 60°C



Temperature Sensors

NXP Temp Sensor Portfolio

Accuracy



Local only

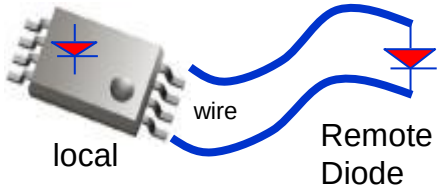
Remote and Local

Remote & Local with Voltage Monitor

Not Released

Local Temp Sensor

Local + Remote Temp Sensor



NXP Temp Sensor Selection Table

Part Number	Local Channels	Remote Channels	Accuracy Local (max)	Accuracy Remote (max)	Temp Resolution / A/D Resolution Bits	Power Supply Voltage Range	Supply Current Operating uA	Supply Current Standby uA	Package Option
LM75A	1		±2°C		0.125/11	2.8-5.5	1000	3.5	SO8 TSSOP8
LM75B	1		±2°C		0.125/11	2.8-5.5	300	1	SO8, TSSOP8 XSON8, HWSON8
SE95	1		±1°C		0.125/11	2.8-5.5			SO8, TSSOP8
NE1617A	1	1	±2°C	±3°C	1.0/8	3.0-5.5	70	3.0	QSOP16
NE1619	1	1*	±3°C	±5°C	1.0/8	2.8-5.5	500	100	QSOP16
SA56004	1	1	±2°C	±1°C	0.125/11	3.0-5.5	500	10	SO8, TSSOP8, HVSON8
SE97B	1		±1°C		0.125/11	3.0-3.6	400	3	HWSON8
SE98A	1		±1°C		0.125/11	1.7-3.6	400	5	TSSOP8, HWSON8

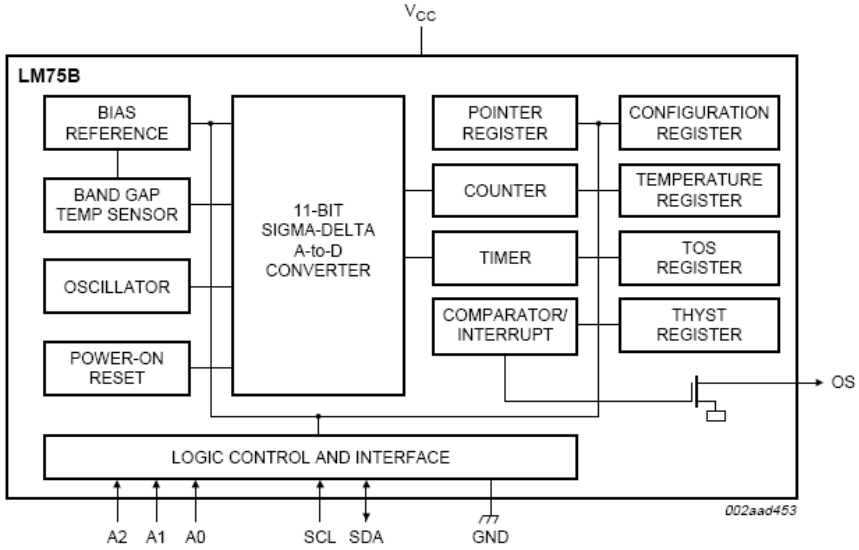
*** NE1619 monitor different power supplies: 12 V, 5 V, 3.3 V, 2.5 V, VCCP, VDD**

#PCTx075 will attempt to spec 2.5V @ room

LM75B - Digital Temp. Sensor & Thermal Watchdog

Features

- Pin-for-pin replacement for industry standard LM75 and LM75A
- I²C-bus interface - 8 devices on the same bus
- Power supply range from 2.8 V to 5.5 V
- Temperatures range from -55 °C to +125 °C
- Frequency range 20 Hz to 400 kHz with bus fault time-out to prevent hanging up the bus
- 11-bit ADC - temperature resolution of 0.125 °C
- Temperature accuracy of:
  - ±2 °C from -25 °C to +100 °C
  - ±3 °C from -55 °C to +125 °C
- Programmable temperature threshold and hysteresis set points
- Max supply current of 1.0 µA in shutdown mode
- Stand-alone operation as thermostat at power-up
- ESD protection exceeds 4500 V HBM per JESD22-A114, 450 V MM per JESD22-A115 and 2000 V CDM per JESD22-C101
- Small 8-pin package type: XSON8U & HWSON8 (metal pad)



Type number	Topside mark	Package		
		Name	Description	Version
LM75BD	LM75BD	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
LM75BDP	LM75B	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
LM75BGD	75B	XSON8U	plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body 3 x 2 x 0.5 mm	SOT996-2
LM75BTP	M75	HWSON8	plastic thermal enhanced very very thin small outline package; no leads; 8 terminals, 2 x 3 x 0.8 mm	SOT1069-2

In **Production**

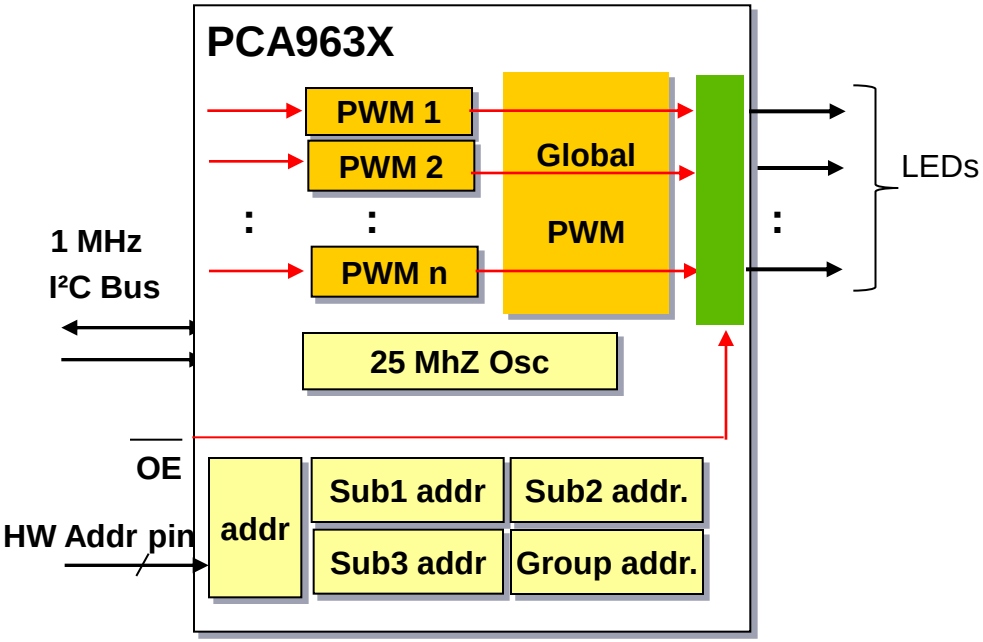
LED Controllers

LED Controller Value Proposition

- **Why used?**
  - Offer flexible software based complex dimming operation (i.e. ramp rate with global PWM)
  - Offload CPU from simple blinking & dimming operations
- **Where used?**
  - Brightness control (Dimmers)
  - Keypad and LCD backlighting (Dimmers)
  - Equipment status indicator and control (Blinkers)
- **Why NXP LED Controller?**
  - 20 V output (40 V available)
  - 1MHz Fm+ and 5MHz UFM control interface
  - Enhance system reliability with thermal shutdown and over current limit protection
  - Minimizing supply voltage ripple with programmable LED outputs phase shifting
  - Per channel peak current control by Individual DAC
  - Sub address allows groups of LED controllers blink/dim at the same time
  - Thermally enhanced package HTSSOP

I2C LED Controller – Voltage Switching Source

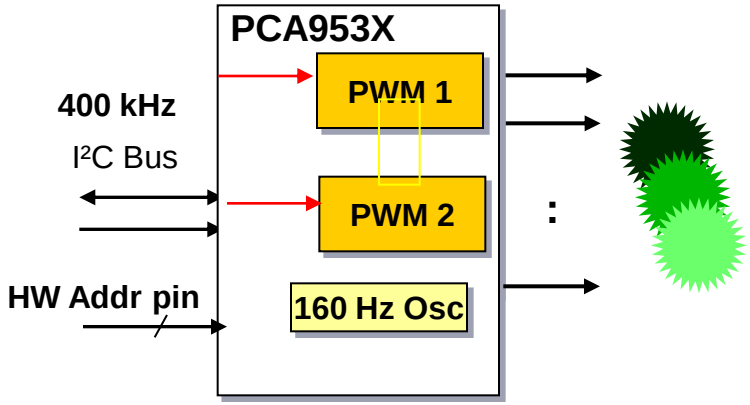
RGBA Dimmer/Blinker – PCA9633/4/5



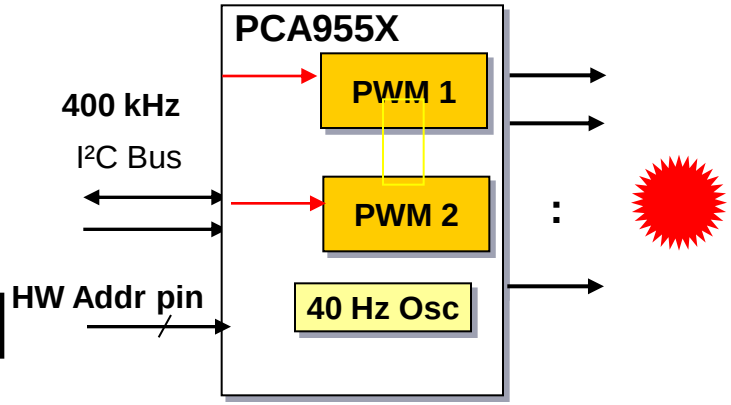
- PCA9633TK (QFN8)= Normal Power
- PCA9632TK (QFN8)= Low Power

PCA9632TK is capable of interfacing with 1.8V I2C-bus, 2.8V VCC

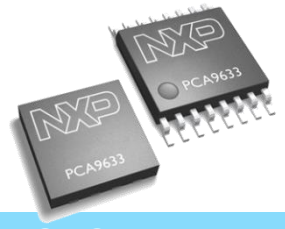
Dimmer – PCA9531/2/3



Blinker – PCA9551/2/3



LED Controllers – Product Summary



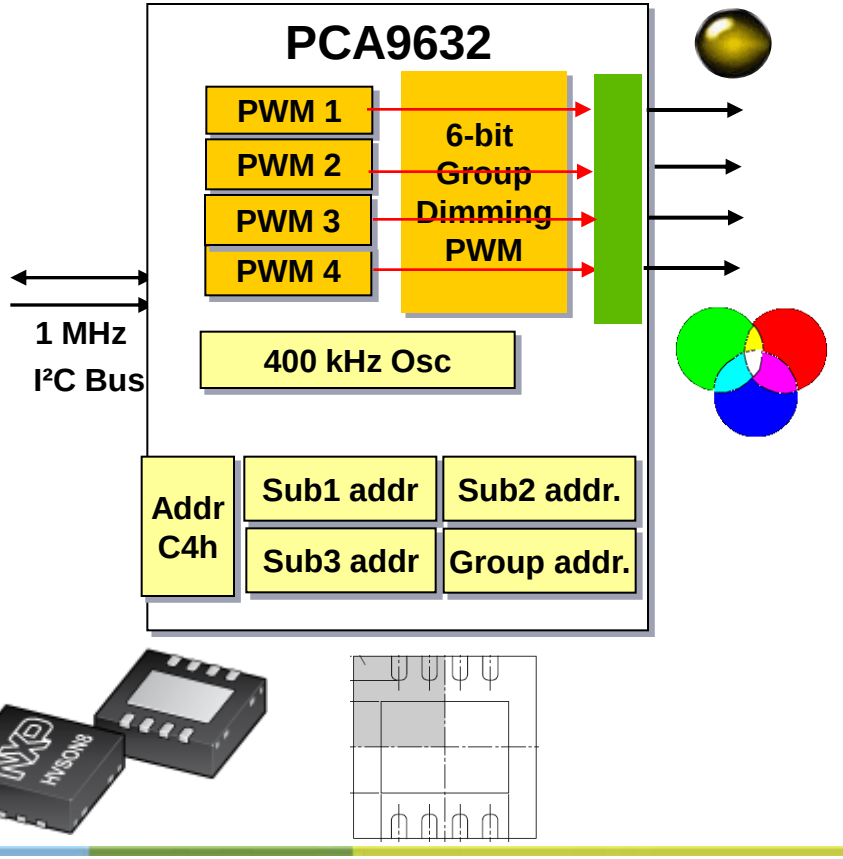
Part #	OUTPUT					FUNCTION		
	#of channel	VS	CC	VDD	IDD	Control I/F	PWM	Function
PCA9901	1		●	5 V	20mA	1-Wire	12 bit indiv	Blinker
PCA9922	8		●	5 V	60mA	Serial in/out	12-bit indiv	Blinker
PCA9550,3,1,2	2,4,8,16	●	-	5 V	25mA	400kHz Fm	8-bit Indiv	Blinker
PCA9530,3,1,2	2,4,8,16	●	-	5 V	25mA	400kHz Fm	8-bit Indiv	Dimmer
PCA9633,4,5*	4,8,16	●	-	5 V	25mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9632	4 (low power)	●	-	5 V	25mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9624,2,6	8,16,24	●	-	40V	100mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9685*	16	●	-	5 V	25mA	1 MHZ Fm+	12 bit indiv	Dimmer
PCA9952,5**	16	-	●	40V	57mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCU9654,5,6	8,16,24	●	-	40V	100mA	5 MHZ UFM	8-bit Indiv/global	Dimmer
PCU9955	16	-	●	40V	57mA	5 MHZ UFM	8-bit Indiv/global	Dimmer

*PCA9635PW/Q900 and PCA9685PW/Q900 ares AEQ100 qualified
** PCA9955TW is under evaluation for AEQ100 qualification

PCA9632: 4 channel I2C LED controller for Low Power Applications

Features

- 4 Push-Pull output driver, 25mA sink, 10mA source with I²C-bus interface
- Low stand-by current (1µA to 15 uA)
- LED On/Off, Bright/Dim, Blinking controls
- Blink rate: 40ms to 10.73 seconds
- Individual 8-bit PWM for LED intensity control
- Global 6-bit PWM for color dimming control
- Support 1.8V I/O / 2.3V to 5.5V VCC
- ALLCALL, SUBCALL for zone dimming
- Glue less connection to external FETs for higher LED drive
- Drop-in low power upgrade for PCA9633
- HVSON8 (TK) 3x3x 0.8 package

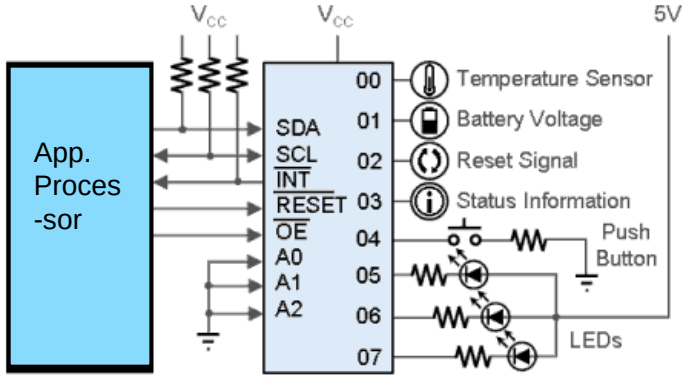


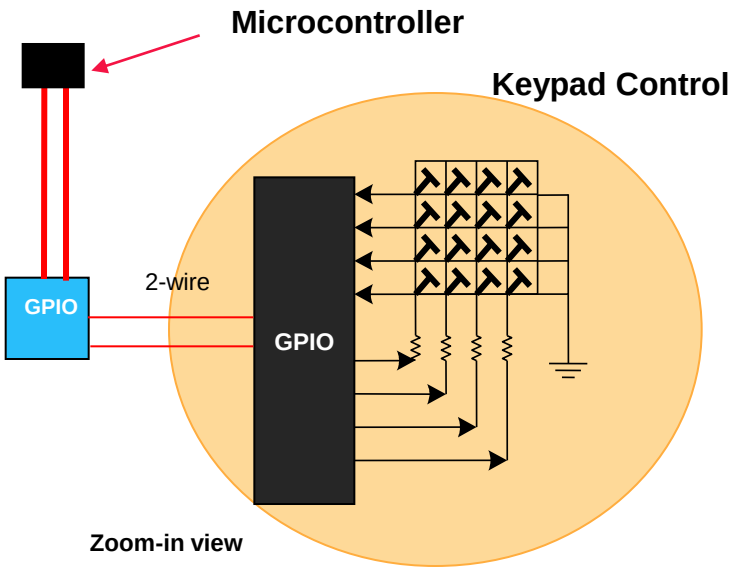
In Production

I2C GPIO Expander

GPIO Expander Value Proposition

- **Why used?**
  - Easily **adds higher voltage I/O** via I²C-bus
  - Additional inputs for keypad and signal monitoring
  - Additional outputs for LED control and sensors.
- **Where used?**
  - Combats **"Feature Creep"** by expanding I/O port instead of new µC
  - Allows **seamless migration** to newer µC and still keeps the same peripherals
  - **Eliminates costly congested PCB** since a trace or wire is not needed for each signal
- **Why NXP GPIO expanders?**
  - Largest selection of 4, 8, 16 and 40-bit GPIO in Quasi-bidirectional and Push-pull outputs with Interrupt and/or reset in small packages'
  - Wide selection of low power/low voltage (1.8V) GPIO expander portfolio suitable for mobile applications
  - Continuous innovation with new features





I/O Expanders with Flexible Output Structures

Quasi-Output Structure:

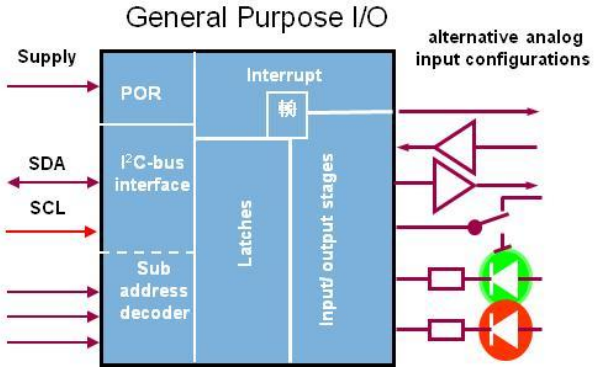
- Strong PMOS transistor is turned on only during the LH transition and turned off during static drive
- Weak pull-up current source (100µA) at the output
- Used in low-power applications where the 100-µA drive is sufficient to bias the inputs of CMOS devices
- May be reconfigured as an input or output without the need of a port configuration register

# of Outputs	Interrupt	Reset	Interrupt & Reset	2Kbit EEPROM	Interrupt and 2Kbit EEPROM
8	PCF8574/74A, PCA8574/74A, PCA9674/74A	PCA9670	PCA9672	PCA9500/58	PCA9501
16	PCF8575/75C, PCA9675	PCA9671	PCA9673	-	-

Totem-Pole Output Structure:

- Upper PMOS transistor is turned on during LH transition and static high drive. Up to 10mA (or 25mA) of high drive
- Some devices have weak pull-up resistors at the output
- Used in applications requiring high drive for heavy loads
- Extra command byte needed to switch an I/O pin between input and output

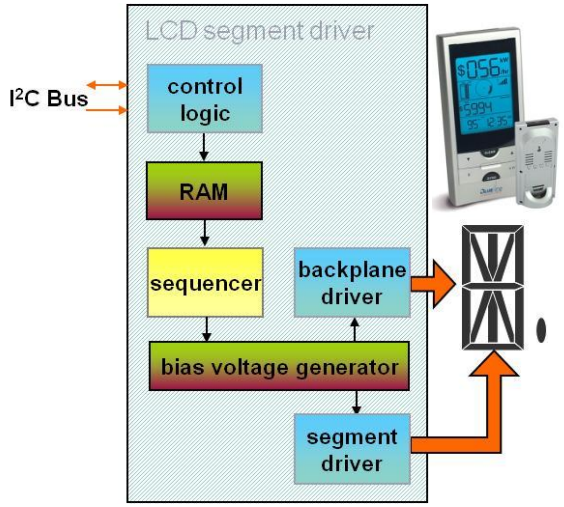
# of Outputs	None	Reset	Interrupt	Interrupt and Reset
4	PCA9536			PCA9537
8		PCA9557	PCA9534/54/54A	PCA9538, PCA9502, PCA9574
16	-	-	PCA9535/35C/55	PCA9539/39R, PCA9575
40	-	-		PCA9505/06, PCA9698



LCD Drivers

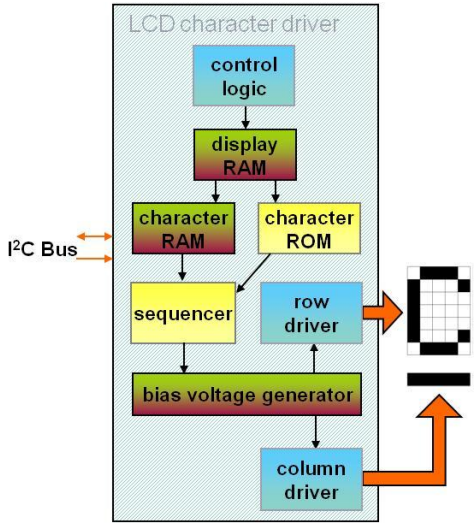
LCD Drivers: Differentiations

Segment Drivers



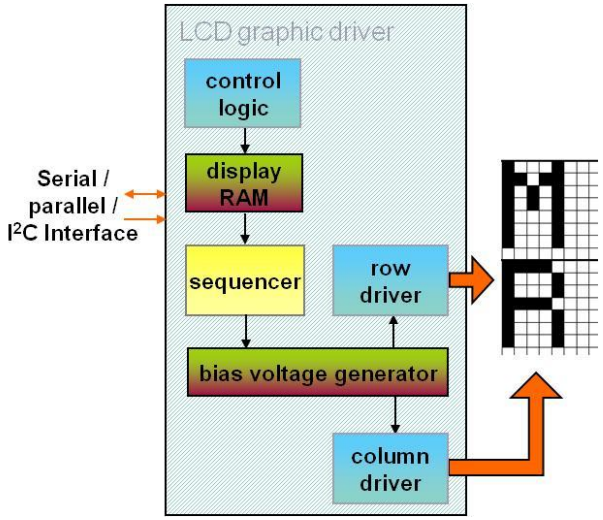
Features:
- Max multiplex rate 1:16 (generally 1:4)
- Wide range of segment outputs
- RAM and auto-incremental addressing
- Low power consumption
- No external component
- Wide power supply range
- Internal LCD bias voltage generation with voltage follower buffers
- Internal oscillator, external clock also possible

Character Drivers



Features:
- Multiplex rate up to 1:18
- On-chip character generator
- 5x7 character + cursor; 5x8 for Kana (Japanese) & user-defined symbols
- On-chip temperature compensation
- On-chip character ROM and RAM
- Low power consumption
- Minimum external components
- On-chip LCD bias voltage generation
- Internal oscillator / external clock

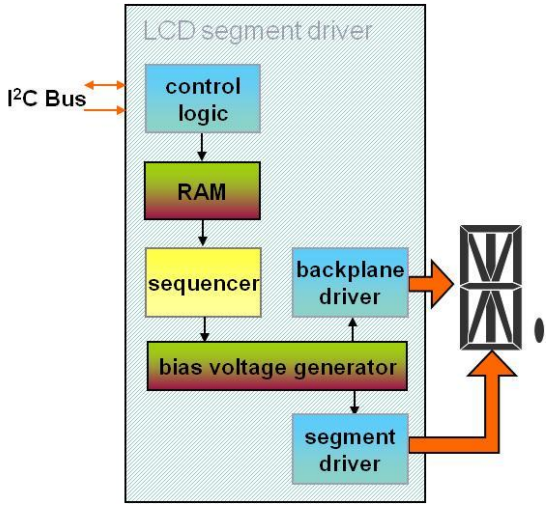
Graphic (Dot Matrix) Drivers



Features:
- Wide range of mux rates to optimize power and display size (S/W selectable)
- On-chip generation of LCD bias voltages
- Low number of external components
- Low power consumption
- Temperature compensation

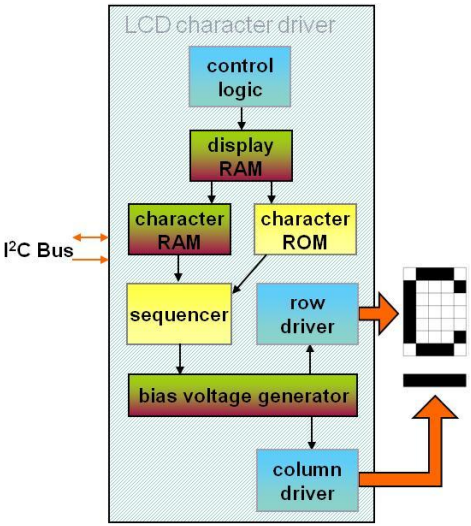
LCD Drivers: Key Products

Segment Drivers



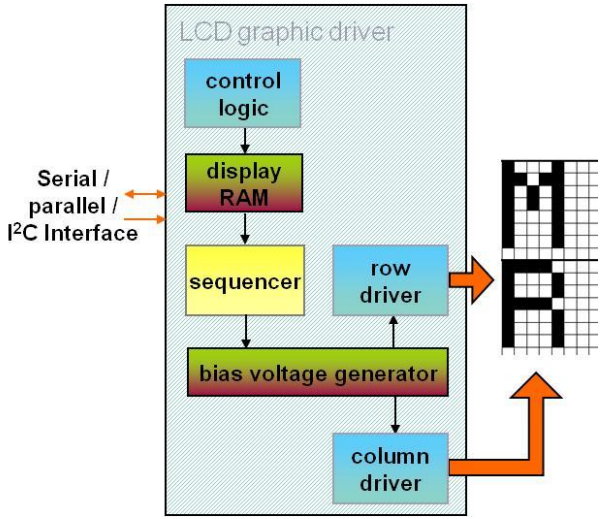
- **PCF85162** 4 x 32 Segments
- **PCF85176** 4 x 40 Segments
- **PCF85134** 4 x 60 Segments
- **PCF85133** 4 x 80 Segments
- **PCF85132** 4 x 160 Segments
- **PCF8536** 8 x 40 Segs + 6PWM NEW
- **PCA9620** 8 x 60 Segments

Character Drivers



- **PCF2113** 2-line x 12-Character Plus 120 icons
- **PCF2116** 2-line x 24-Character
- **PCF2119** 2-line x 16-Character Plus160 icons

Graphic (Dot Matrix) Drivers



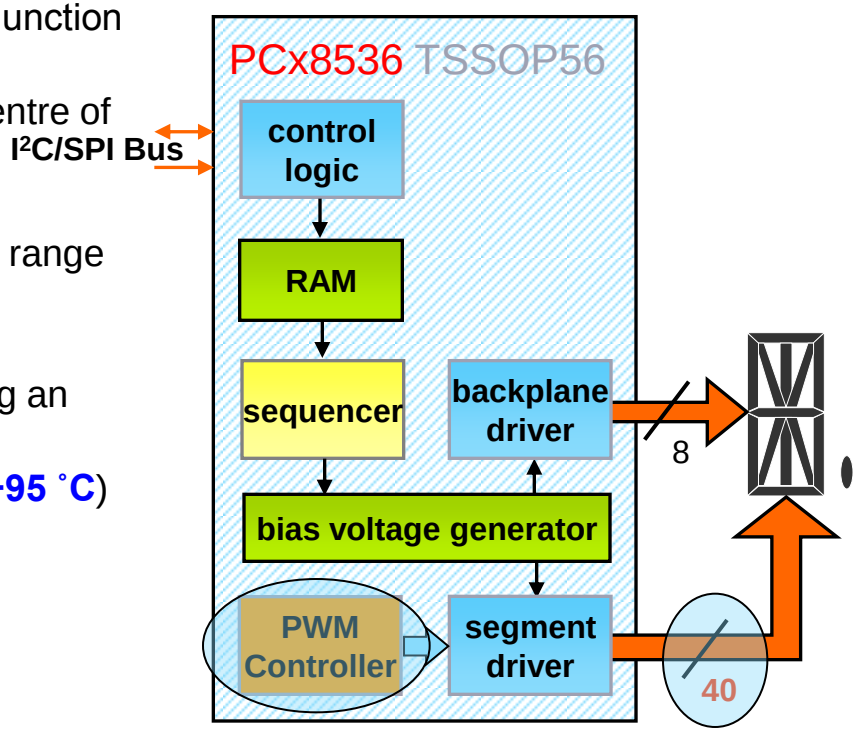
- **PCF8531** 34 x 128 Small 4-x-20 Text Characters Full Graphics
- **PCF8811** 80 x 128 Large Universal display
- **PCF8578** 8 x 32 (stand-alone) Up to 40,960 dots when combined with 32 **PCF8579**

For Details, see the LCD Drivers Selection Guide

PCF8536: 320-Segment Driver

- Key Features:
  - I²C-bus (PCx8536AT) or SPI-bus (PCx8536BT) interface
  - Interfaces directly to the LCD cells; driving signals are internally generated
  - 40-Segment and 8-Backplane outputs for driving up to 320 Segments in a 1:8 multiplex rate
  - Supports mux rates of 1:4, 1:6, and 1:8
  - 7-Bit PWM outputs for controlling up to 6 LED's in conjunction with external transistors
  - Configurable backplane outputs; either pinout in the centre of the segment outputs or at the edge of the device
  - Programmable Line Inversion or Frame Inversion
  - Programmable and calibrated Frame Frequency in the range of 60Hz to 300Hz in steps of 10Hz (typical)
  - Wide digital power supply range from 1.8V to 5.5V
  - Wide VLCD range from 2.5V to 6.5V (**9.0V**) when using an external supply
  - Extended operating temperature range up to +85 ˚C (**+95 ˚C**)
  - **AEC-Q100 automotive compliant qualification for robustness and reliability**

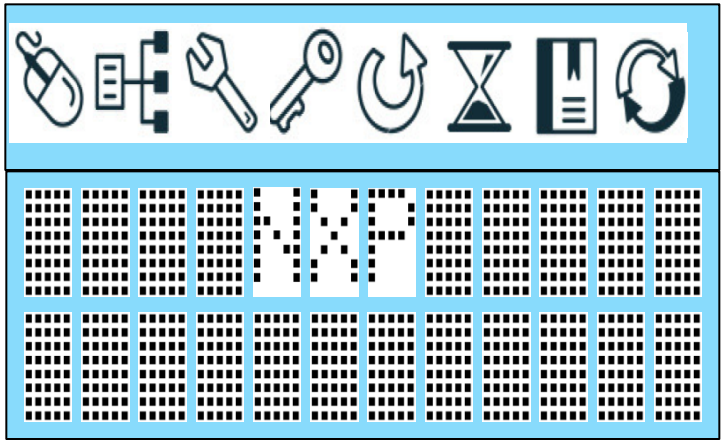
Mux	# Display Segments	
	w/o PWM	w/ 6x PWM
1:4	176	152
1:6	252	216
1:8	320	272



In Production

PCF2113 - Low power CMOS LCD controller

- Single-chip LCD controller/driver
- 2-line display of up to 12 characters + 120 icons, or
- 1-line display of up to 24 characters + 120 icons
- Icon blink function
- Very low current consumption (20 µA to 200 µA):
  - Icon mode: < 25 µA (only icon mode active)
  - Power-down mode: < 2 µA
- Integrated charge pump
- Temperature compensation
- LCD bias voltage generation on chip
- A minimum of external components required
- Logic supply voltage range V_{DD1} - V_{SS1} = 1.8 V to 5.5 V
- V_{LCD} generator supply voltage range V_{DD2} - V_{SS2} = 2.2 V to 4.0 V
- Display supply voltage range V_{LCD} - V_{SS2} = 2.2 V to 6.5 V



In Production

PCF2119 - Low power CMOS LCD controller

Key Features

- Single-chip LCD controller and driver
- 2-line display of up to 16 characters plus 160 icons or 1-line display of up to
- 32 characters plus 160 icons
- 5 x 7 character format plus cursor; 5 x 8 for kana (Japanese) and user defined symbols
- Reduced current consumption while displaying icons only
- Icon blink function
- On-chip:
  - Configurable 4, 3, or 2 times voltage multiplier generating LCD supply voltage, independent of VDD, programmable by instruction (external supply also possible)
  - Temperature compensation of on-chip generated VLCDOUT
  - Generation of intermediate LCD bias voltages
  - Oscillator requires no external components (external clock also possible)
- Display Data RAM (DDRAM): 80 characters
- Character Generator ROM (CGROM): 240 characters (5 x 8)
- Character Generator RAM (CGRAM): 16 characters (5 x 8); 4 characters used to drive 160 icons, 8 characters used if icon blink feature is used in application
- 4-bit or 8-bit parallel bus and 2-wire I2C-bus interface

In Production

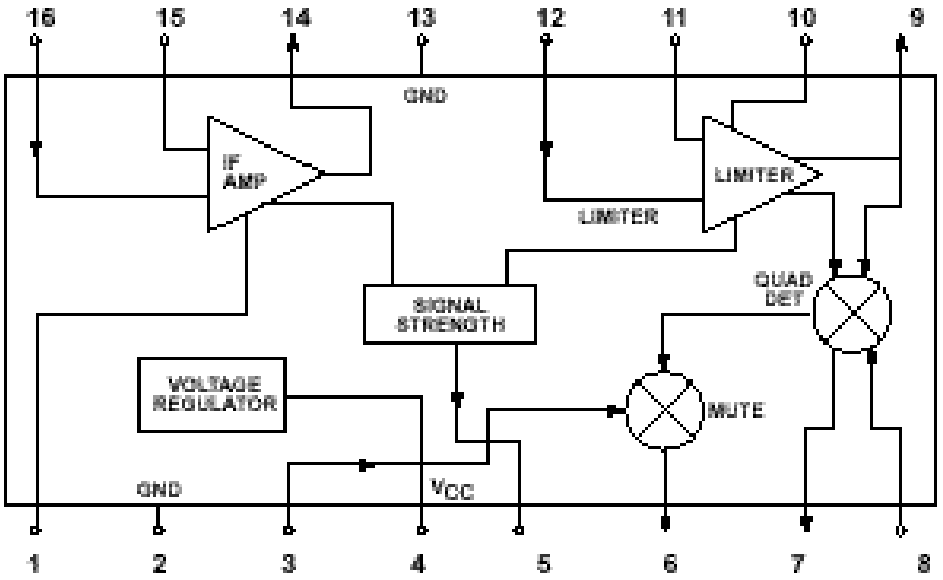
RF/IF Products

NXP's RF IF Building Block Portfolio

- LV FM IF Systems (SA604A, SA614A)
- Narrow Band/Wide Band FM RF/IF Receivers (SA605DK, SA615DK)
- Narrow Band FM RF/IF Receivers (SA606DK, SA616DK, SA676DK, SA58640DK, SA607DK, SA608DK)
- Wide Band FM RF/IF Receivers (SA636DK, SA58641DK, SA639DH)
- SPDT Switches (SA630D & SA58643DP)
- LNA & Mixers w/VCO (SA602A, SA612A, SA601DK, SA620DK)
- Integrated Wireless Transceiver (SA58646BD)

SA604AD/01 & SA614AD/01

Low-voltage FM IF System



Features

- IF amp, Limiter amp, RSSI and Quadrature Detector, and Muted and Unmuted audio outputs
- Vcc supply 4.5V to 8.0V
- Icc = 3.3 mA (typical)
- IF BW = 28 MHz
- SO16 Package

AN199 – Designing with SA604A

AN1993 – High Sensitivity Applications of Low-power RF/IF Integrated Circuits

AN1991 – Audio Decibel Level Detector with Meter Driver

In Production

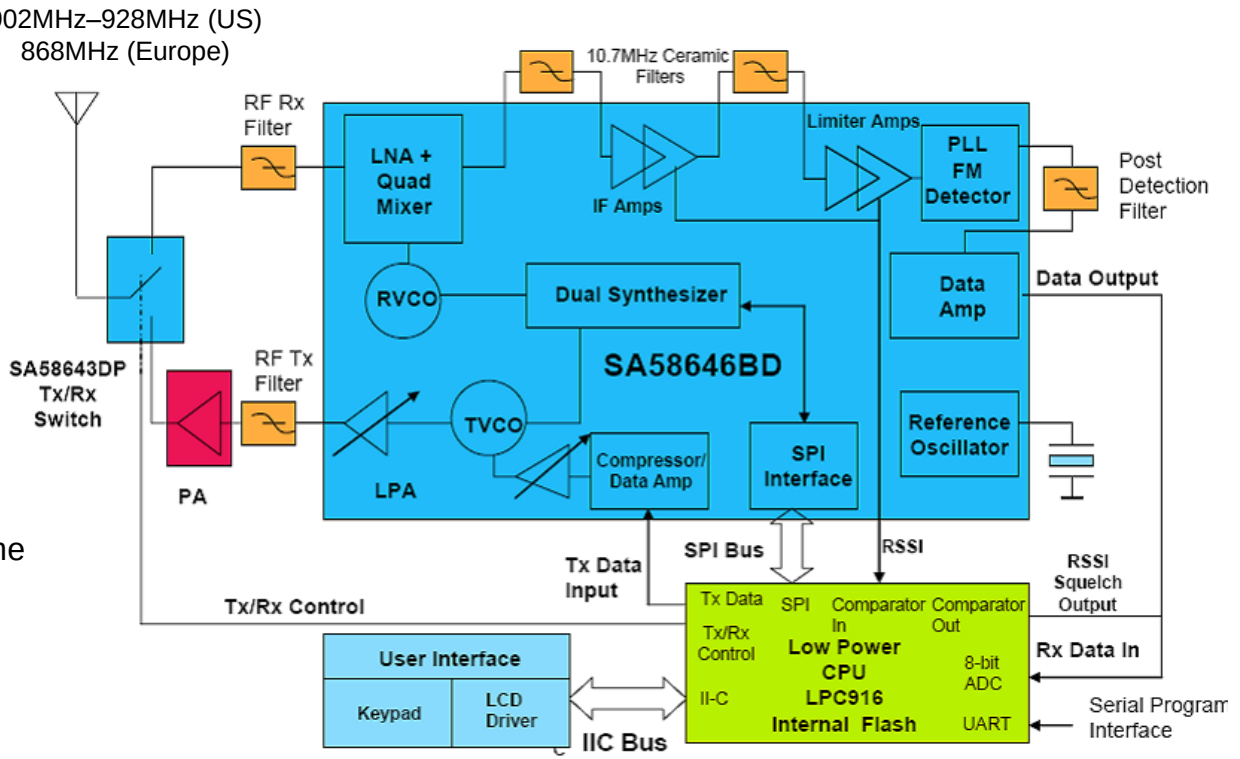
SA58646BD: Integrated Wireless Data Transceiver

Features

- Single frequency conversion RF receiver
- RF transmitter
- Synthesizer
- Baseband RF section
- Baseband TX section
- Microcontroller interface (3-wire)
- Voltage regulator to supply internal PLLs
- Selectable Voltage doubler
- Programmable low-battery detect time multiplexed with RSSI carrier detect

Application

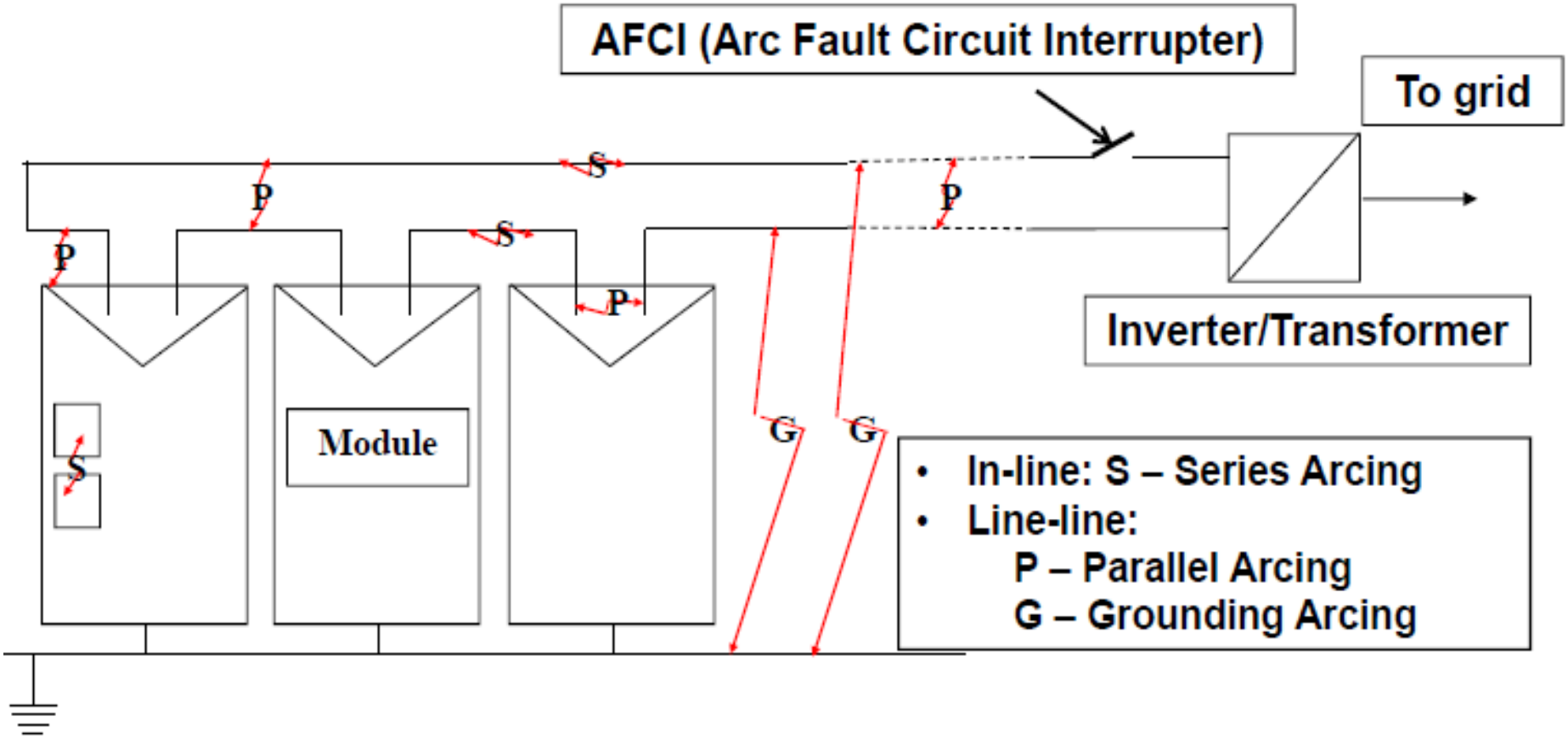
- Low Power RF Remote Control
- Proprietary RF Keyboard/Mouse



In Production

PV Arc Fault Detection Circuit

PV System – Arc Fault types

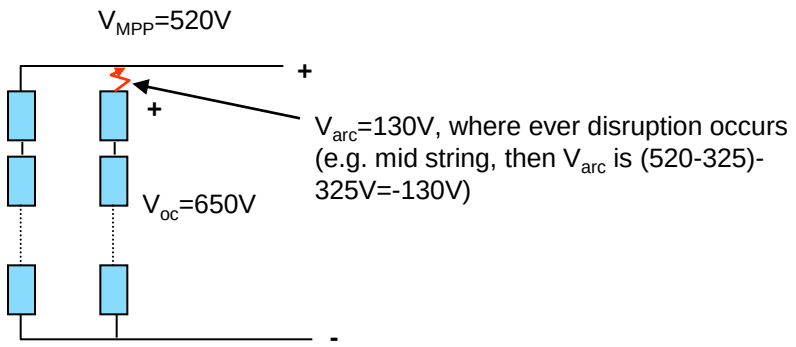


On this chart, AFCI only works for series arcing, if installed on modules, it can protect from parallel or grounding arcing.

Arc Fault Detection Mechanism

Arc Fault Example

- One string disconnected (Voc=650 V)
- All other strings at VMPP=520 V
- V_{arc}=130 V

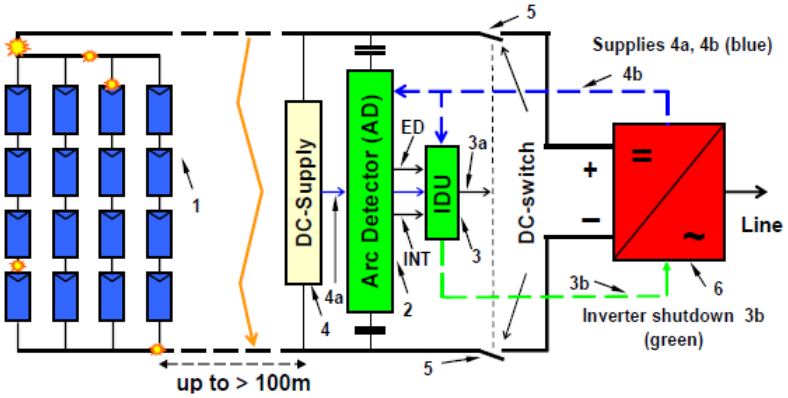


Arc detection

- Arc at any place in the system leads to detectable noise on the DC lines: chaotic behavior DC to μ-wave, highest amplitudes at low frequencies. Arc is detected with dedicated receiver on module or inverter level
  - Tuned resonant circuit (one specific frequency)
  - Analysis of defined frequency band, e.g. 1kHz-130kHz

Arc Fault Circuit Interrupter Examples

Arc detection at central inverter

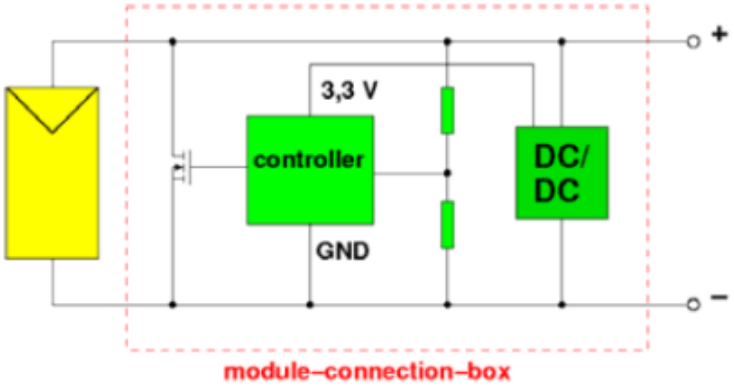


IDU: Intelligent Detection Unit

- DC switch, supply, DSP re-used from inverter
- Only one arc detector

- Not all arcs extinguished (e.g. parallel arc)
- Inverter ripple may induce false triggers

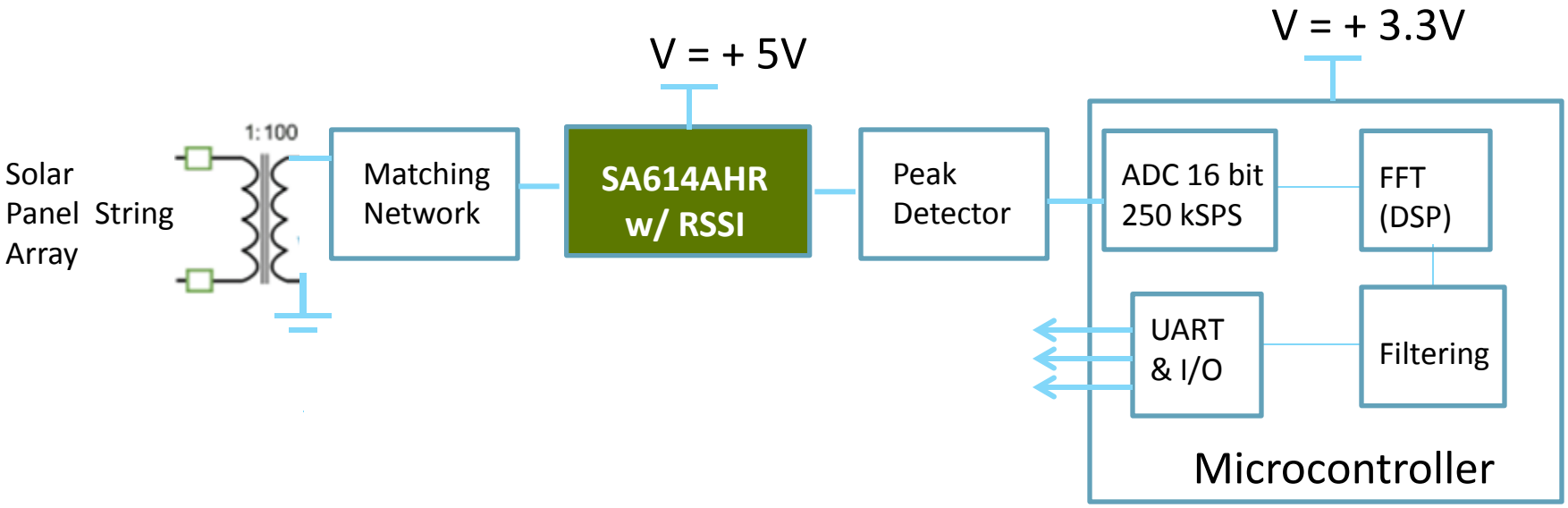
Arc detection on module level



- Less susceptible for inverter noise
- Direct action possible on module level

- One arc detector per module needed

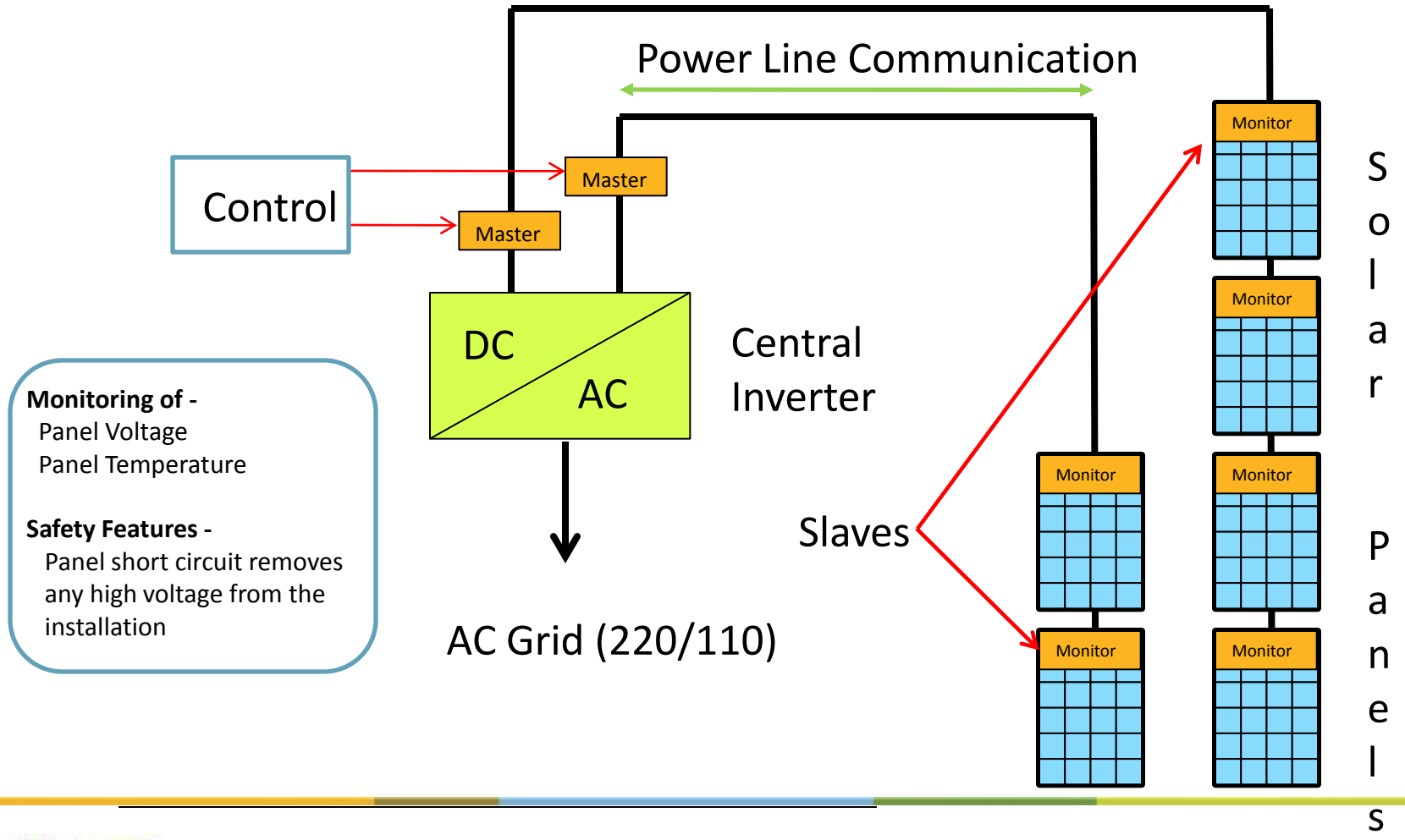
Arc Fault Detection Circuit Diagram



- **Arc detect circuit is inserted in solar panel array string at – polarity input of power converter.**
- **SA614AHR is an IF Subsystem RFIC used for Limiting IF amplifier and RSSI (Reciever Signal Strength Indicator) output**
- **Microcontroller employs 16-bit 250 kSPS ADC , FFT (DSP), digital filtering and UART & I/O interface**

Solar PV Safety & Monitoring Ref Design

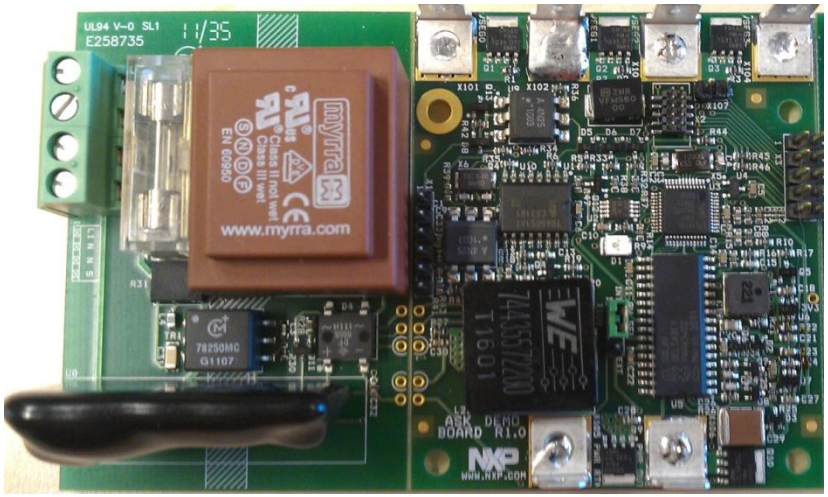
Safety and Monitoring of a Solar System Reference Design



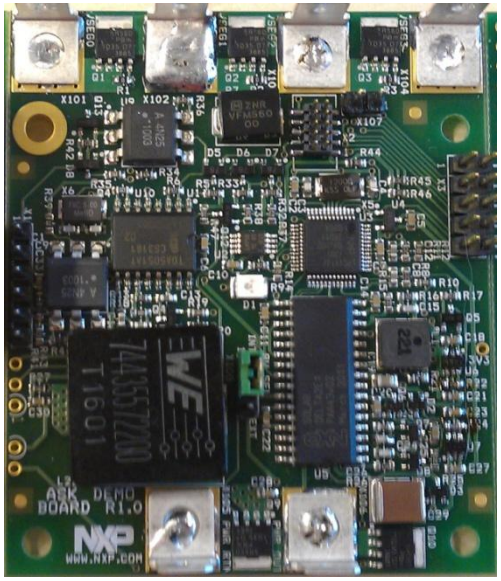
Safety and monitoring of a Solar System

Reference Design Features

- ❑ System is powered by the local Solar panel
- ❑ Bi-directional communication via DC power line infrastructure
- ❑ Safety switch to disconnect the Solar panel from the Inverter in case of Fire
- ❑ Measuring real-time panel temperature and voltage for maintenance & power optimization
- ❑ Simple installation with “Self panel discovering” (linking data to physical location)
- ❑Easy solar PV system control GUI software

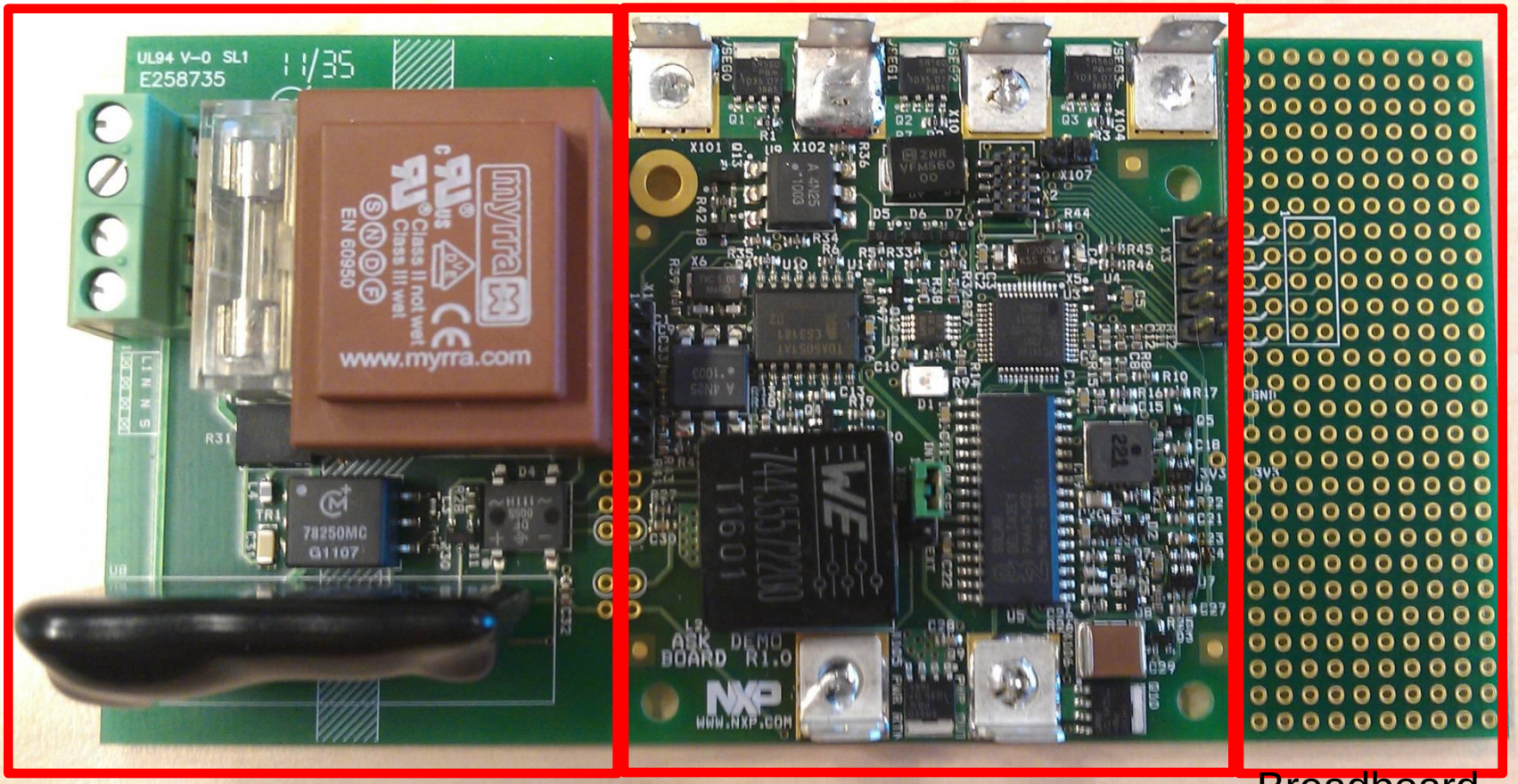


Master Board - Master Controller



Slave Board – Panel

Solar Panel Control & Monitoring Ref Design (1)

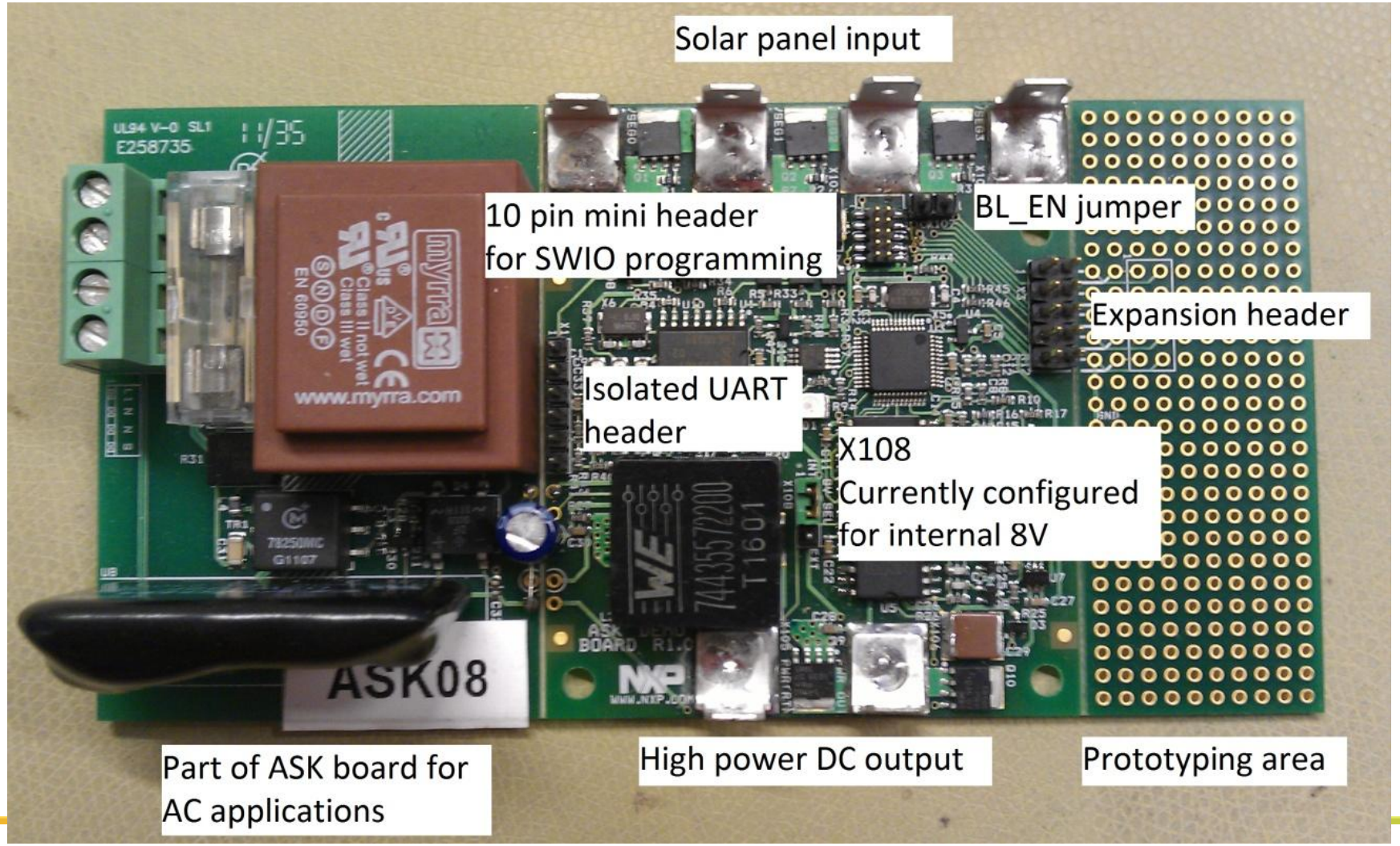


AC-DC Converter for Master Controller

Common in both Master & Slave

Breadboard Space for customization

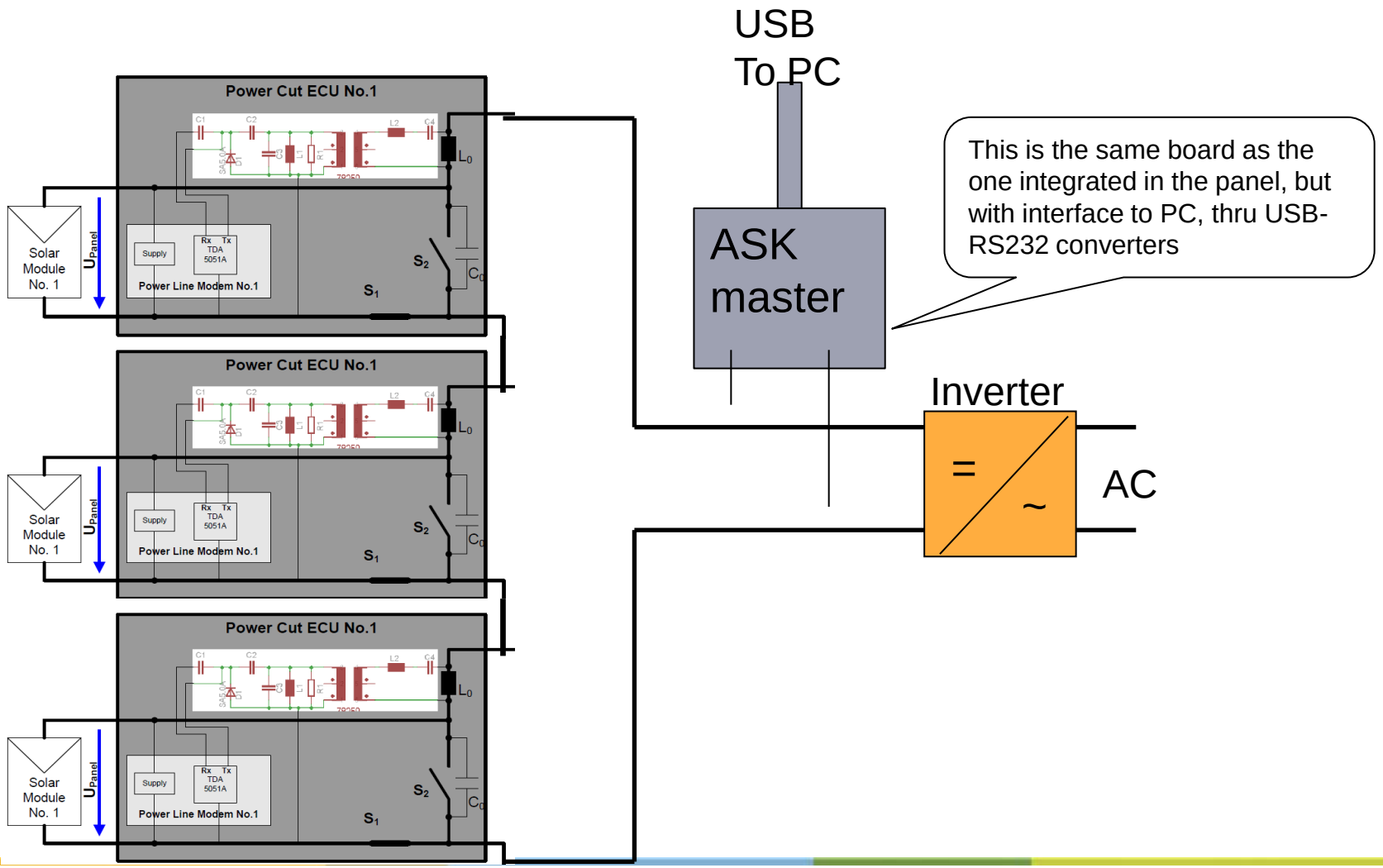
Solar Panel Control & Monitoring Ref Design (2)



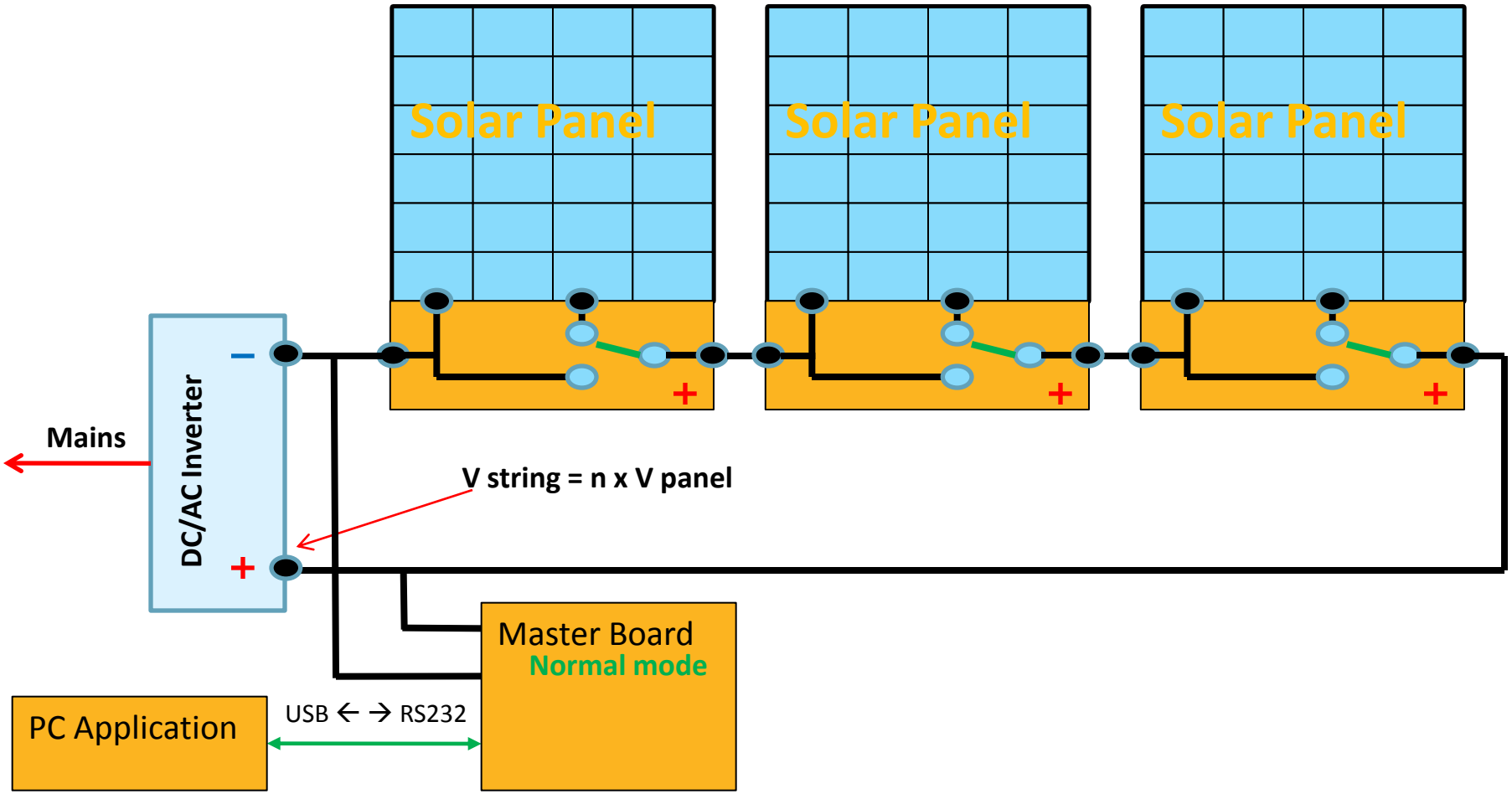
Why NXP Solution?

- **Low Cost Panel Safety & Control Solution**
- **Reliable Operation**
  - Tested the TDA5051A Solar Ref design with solar panels installation on roof of a commercial building with central inverter topology

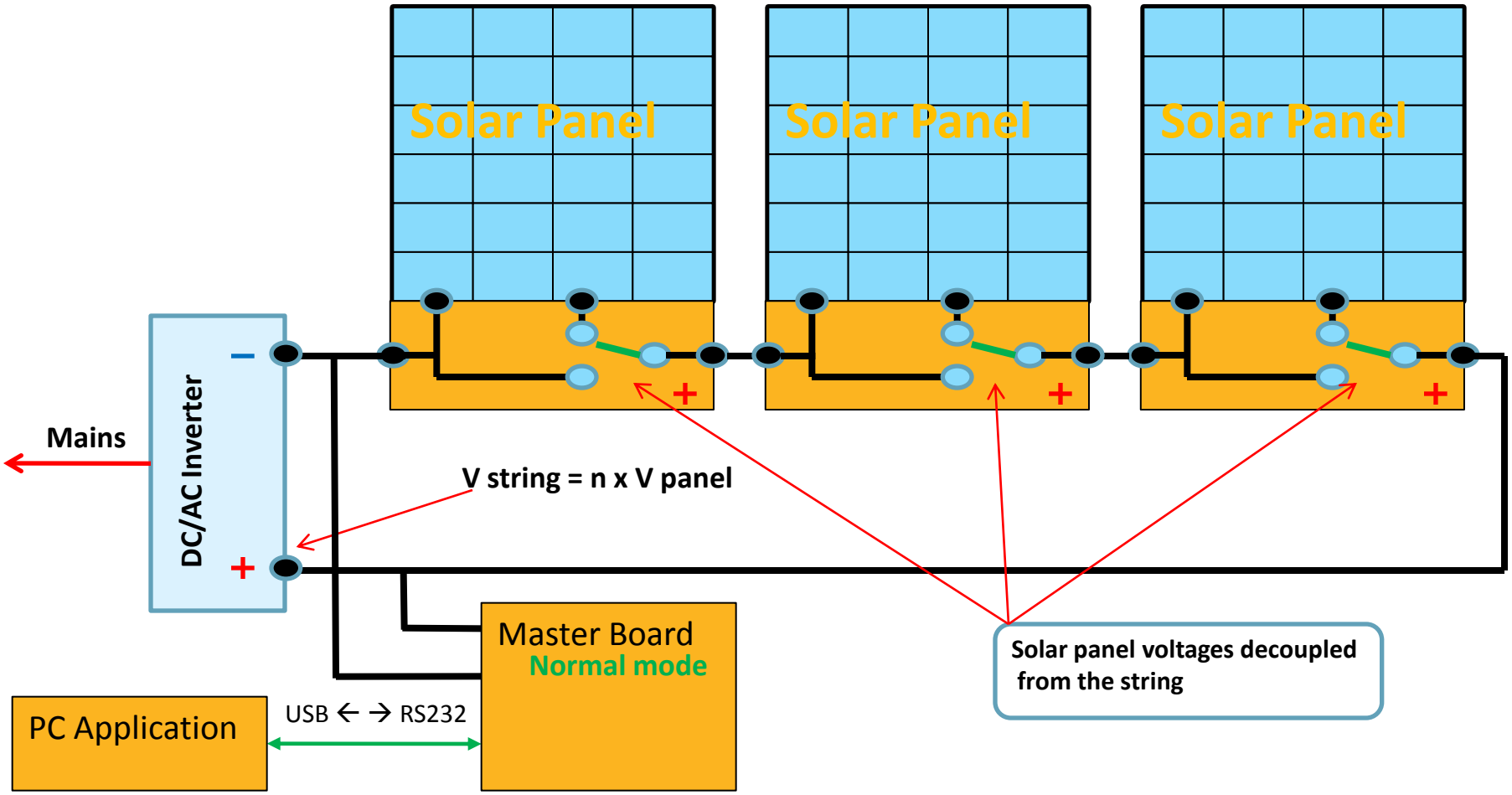
Application Diagram: Solar Panel Control System



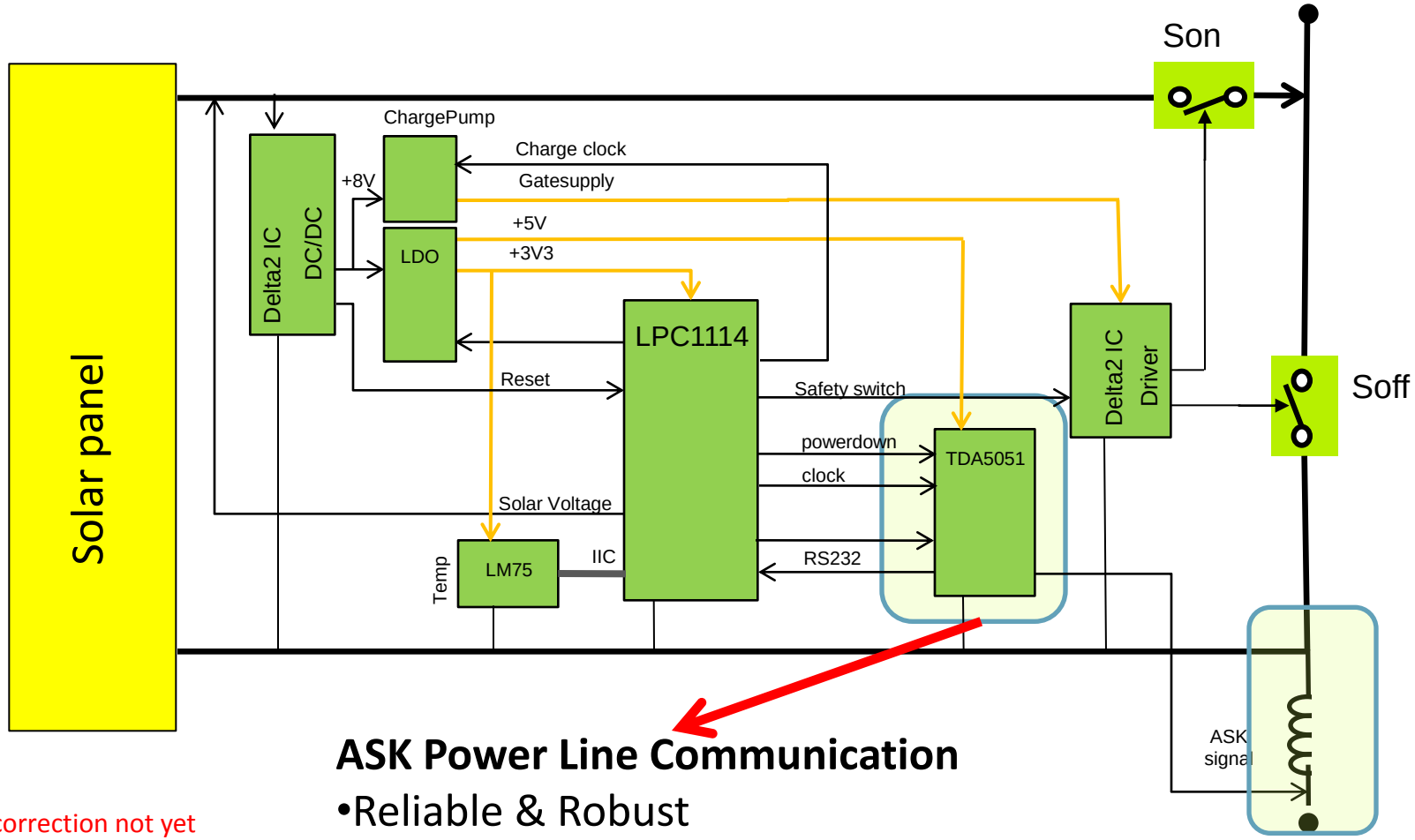
System in Normal mode



System in Normal mode



Block Diagram – Solar Ref Design – Details(1)



ASK Power Line Communication

- Reliable & Robust
- Tested in Actual Solar Installations
- Additional Error correction possible
- Isolated or non Isolated possible

Note:
Add. Error correction not yet implemented. But easily doable
Board is prepared to do both isolated and non-isolated

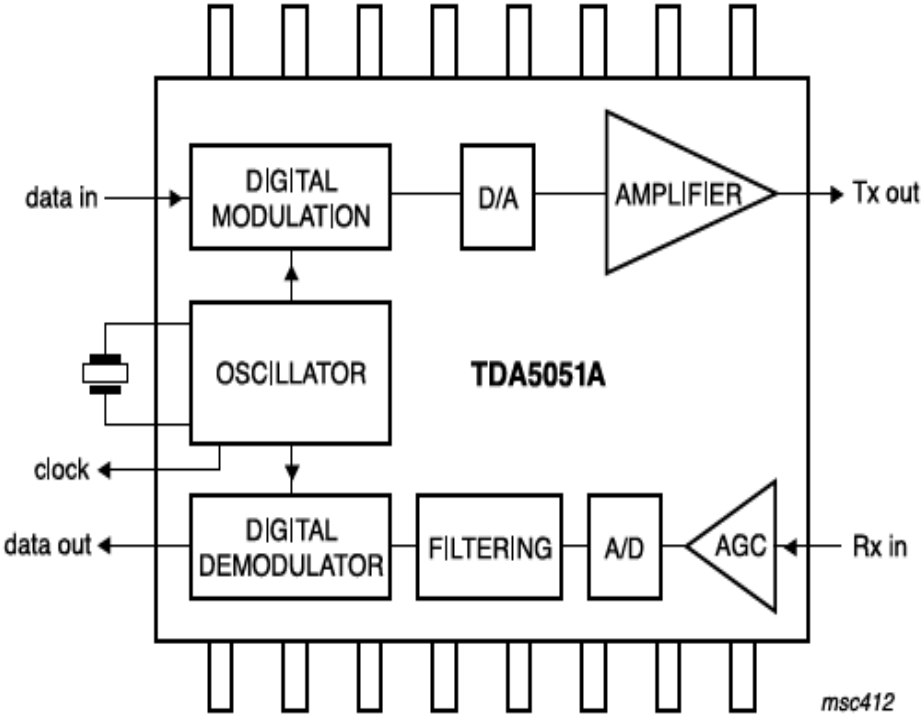
TDA5051A Power Line Modem

Features:

- ASK Power Line Modem operating up to 1200 bps
- 5V supply voltage
- Carrier frequency set by clock from micro controller or on-chip oscillator
- Automatic gain control of receiver input & power overload protection transmitter output
- 8-bit A/D and narrow digital filtering
- Easy compliance with EN50065-1 with simple power line coupling networks
- Low cost solution and easy assembly with SO16 plastic package

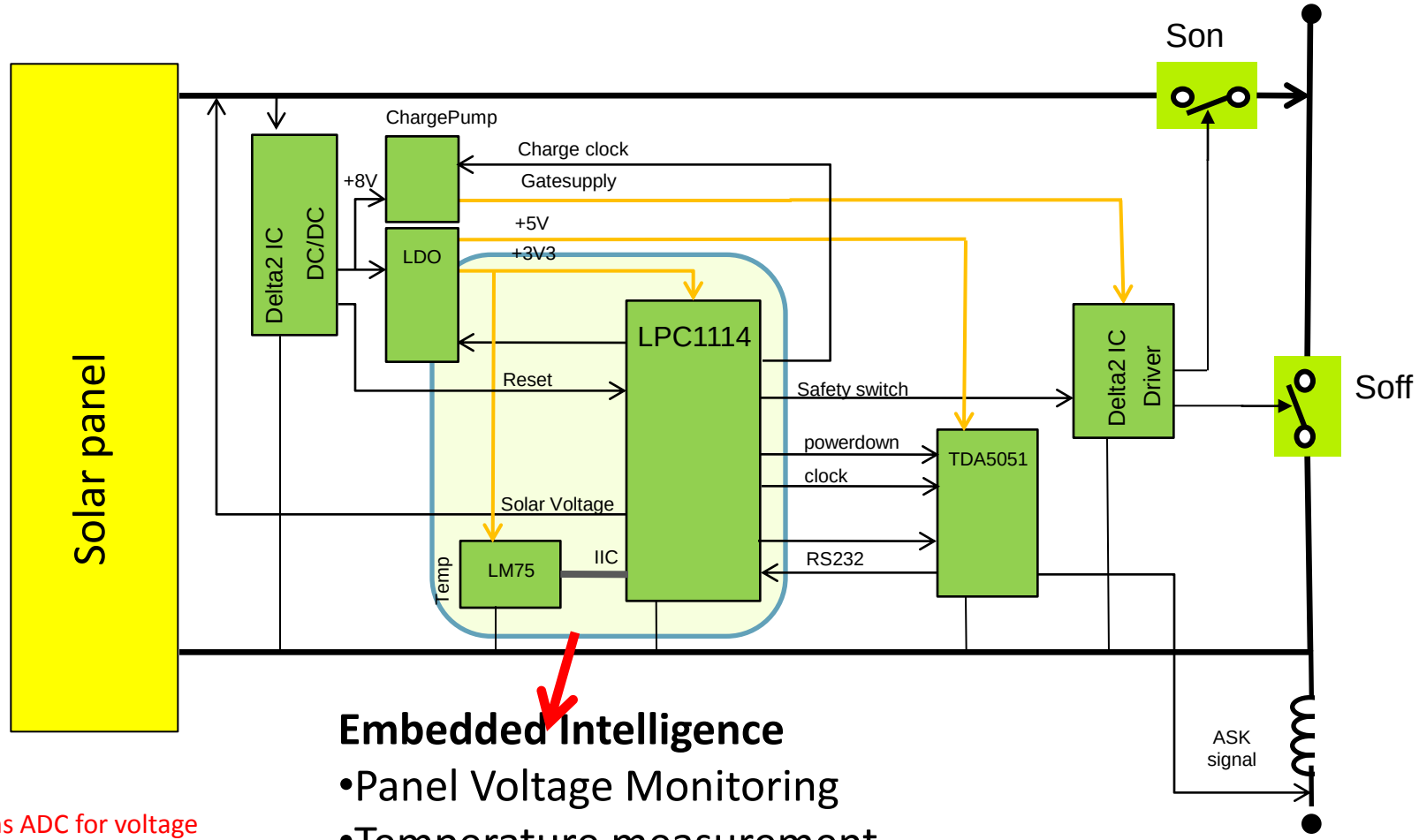
Benefits:

- Low cost digital PL modem solution
- NXP software support
- Robust solution with zero cross detection and redundancy protocol



In Production

Block Diagram – Solar Ref Design – Details(2)



Embedded Intelligence

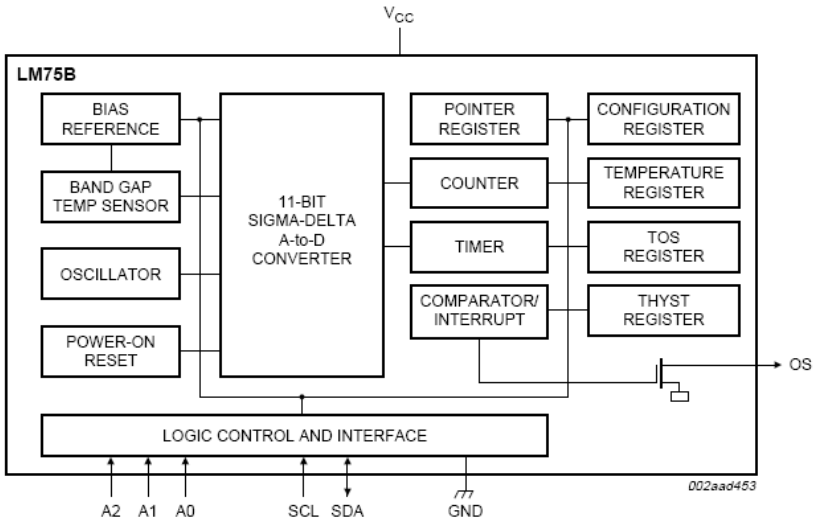
- Panel Voltage Monitoring
- Temperature measurement
- Safety Switch Control
- Heartbeat Based Safety

Note:
LPC contains ADC for voltage monitoring.
Heartbeat is not actually implemented in demo yet

LM75B - Local Digital Temp. Sensor & Thermal Watchdog

Features

- Pin-for-pin replacement for industry standard LM75 and LM75A
- I²C-bus interface - 8 devices on the same bus
- Power supply range from 2.8 V to 5.5 V
- Temperatures range from -55 °C to +125 °C
- Frequency range 20 Hz to 400 kHz with bus fault time-out to prevent hanging up the bus
- 11-bit ADC - temperature resolution of 0.125 °C
- Temperature accuracy of:
  - ±2 °C from -25 °C to +100 °C
  - ±3 °C from -55 °C to +125 °C
- Programmable temperature threshold and hysteresis set points
- Max supply current of 1.0 µA in shutdown mode
- Stand-alone operation as thermostat at power-up
- ESD protection exceeds 4500 V HBM per JESD22-A114, 450 V MM per JESD22-A115 and 2000 V CDM per JESD22-C101
- Small 8-pin package types: SO8 and TSSOP8



Type number	Topside mark	Package		
		Name	Description	Version
LM75BD	LM75BD	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
LM75BDP	LM75B	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
LM75BGD	75B	XSON8U	plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body 3 × 2 × 0.5 mm	SOT996-2

In Production

NXP Temp Sensor Selection Table

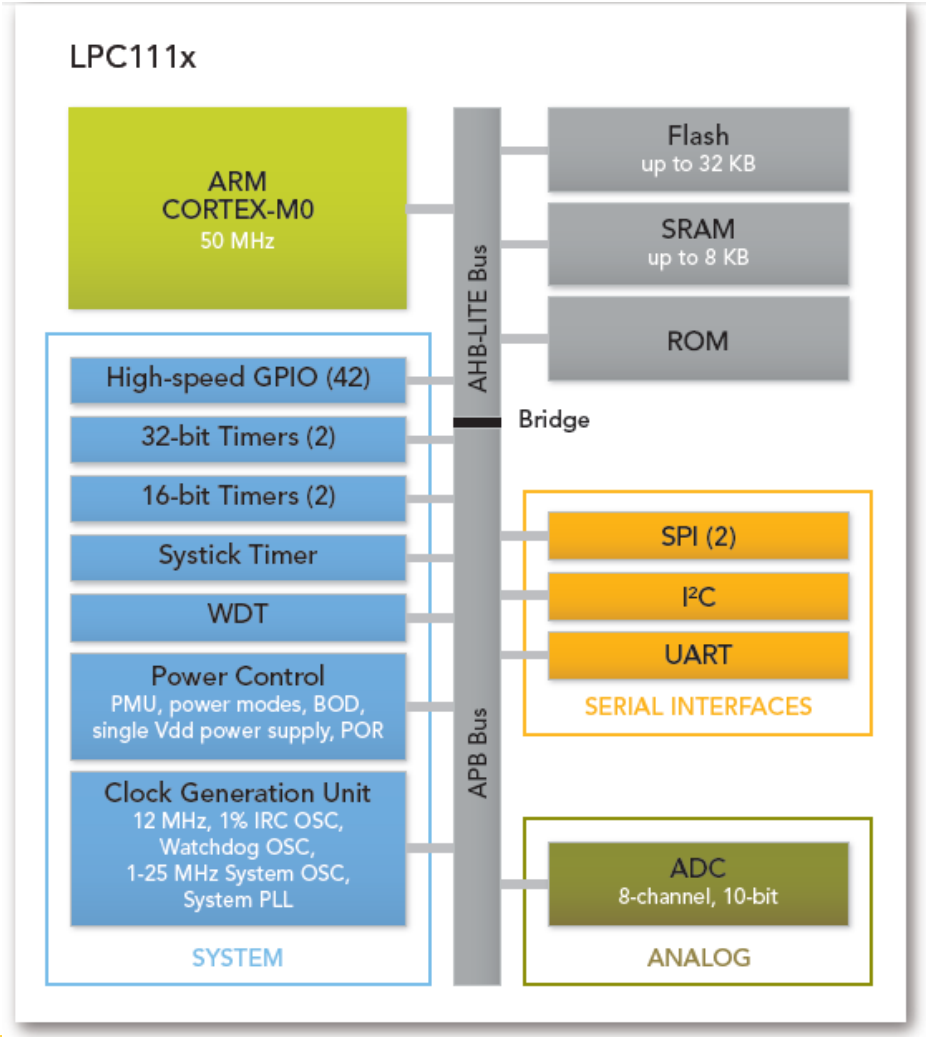
Part Number	Local Channels	Remote Channels	Accuracy Local (max)	Accuracy Remote (max)	Temp Resolution / A/D Resolution Bits	Power Supply Voltage Range	Supply Current Operating uA	Supply Current Standby uA	Package Option
LM75A	1		±2°C		0.125/11	2.8-5.5	1000	3.5	SO-8 TSSOP-8
LM75B	1		±2°C		0.125/11	2.8-5.5	300	1	SO-8 TSSOP-8 XSON-8 HWSON-8
NE1617A	1	1	±2°C	±3°C	1.0/8	3.0-5.5	70	3.0	QSOP-16
NE1619	1	1*	±3°C	±5°C	1.0/8	2.8-5.5	500	100	QSOP-16
SA56004	1	1	±2°C	±1°C	0.125/11	3.0-3.6	500	10	SO-8 TSSOP-8
SE97B	1		±1°C		0.125/11	3.0-3.6	400	3	HWSON-8
SE98A	1		±1°C		0.125/11	1.7-3.6	400	5	TSSOP-8 HWSON-8

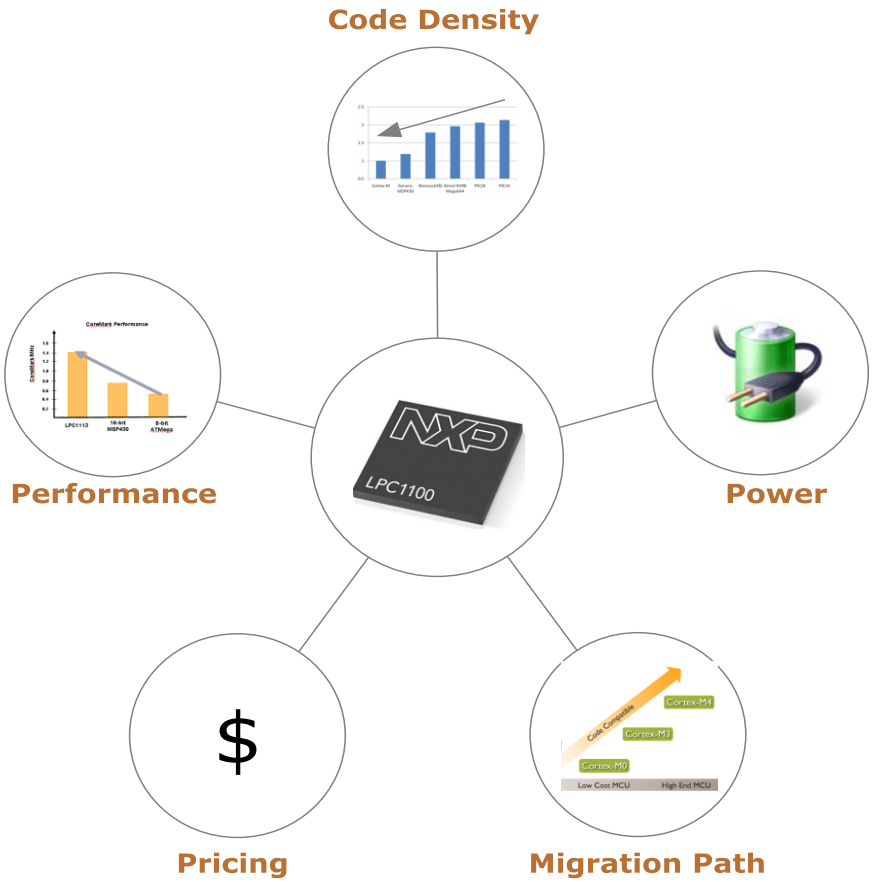
* NE1619 monitor different power supplies: 12 V, 5 V, 3.3 V, 2.5 V, VCCP, VDD

* PCTxx75 data sheet is 2.8V, probably change to 2.7V and trying for 2.5V > room

LPC1114 Cortex-M0 Microcontroller

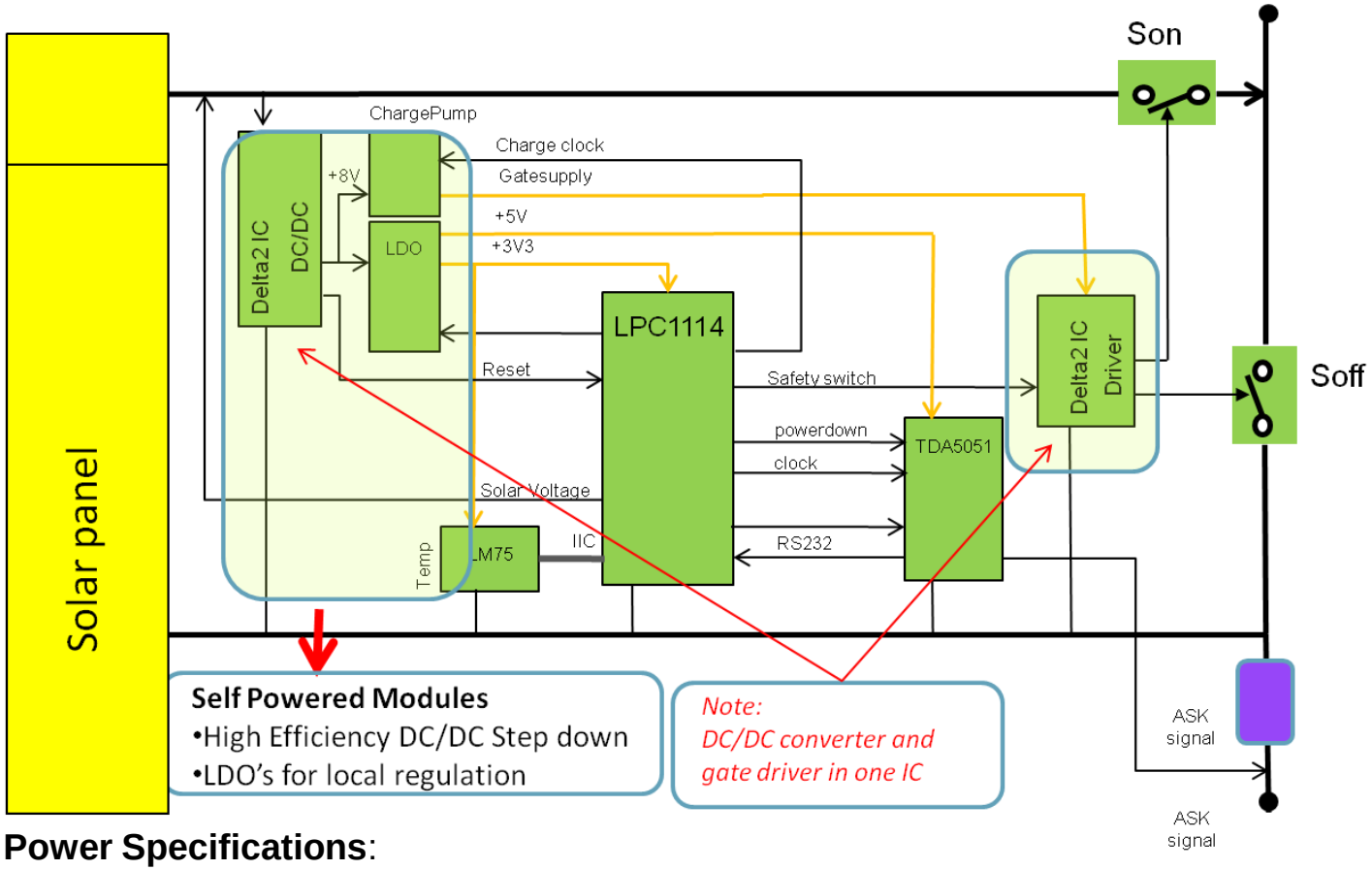
Re-defining 32-bit migration





In Production

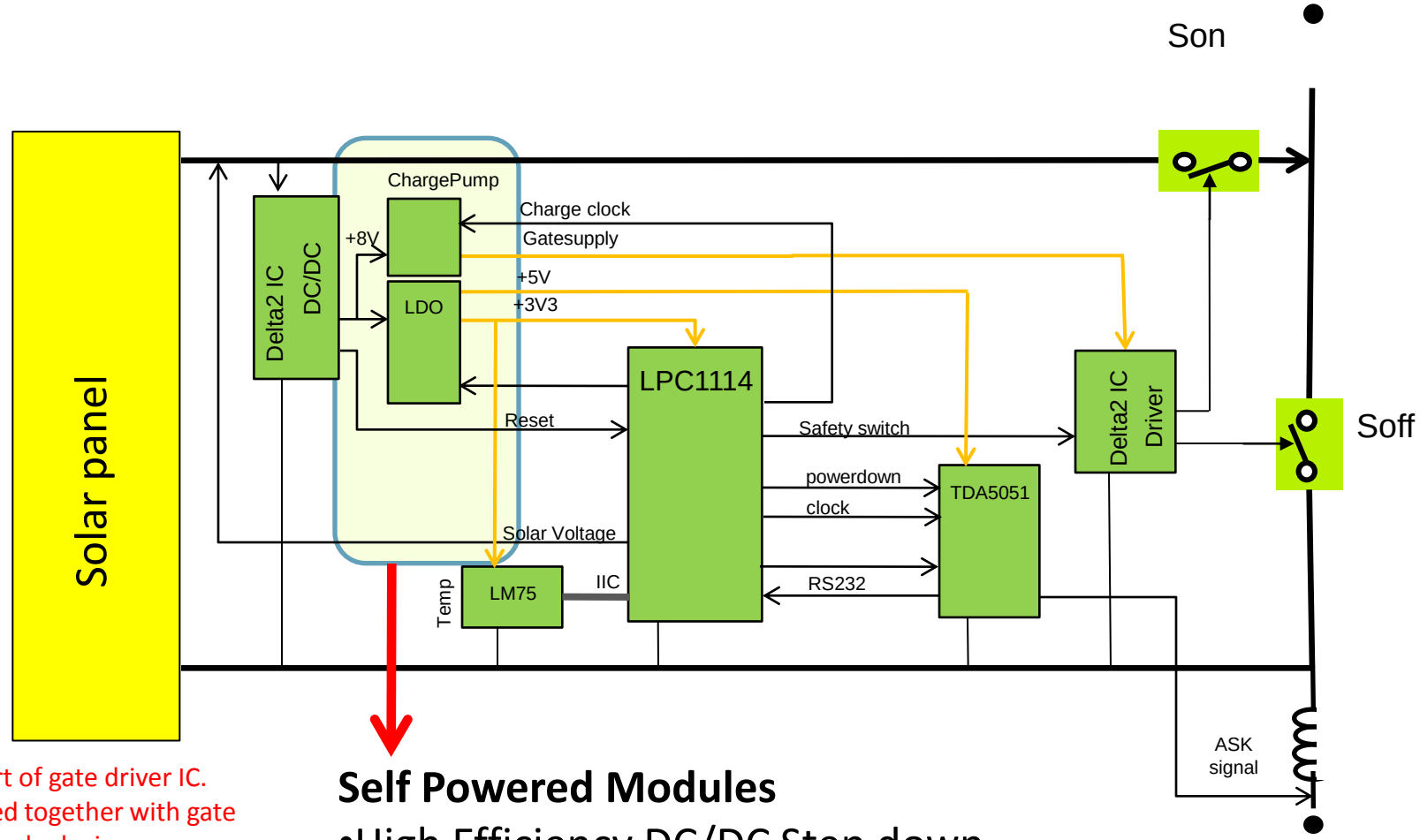
Block Diagram – Solar Ref Design – Details (3)



Power Specifications:

- 3.3V ~10mA continuous
- 5V ~ 70mA peak *(during transmit)*
- $V_{gatedrive}$ ~1mA peak
- Estimated efficiency DC/DC converter > 60%

Block Diagram – Solar Ref Design – Details(4)



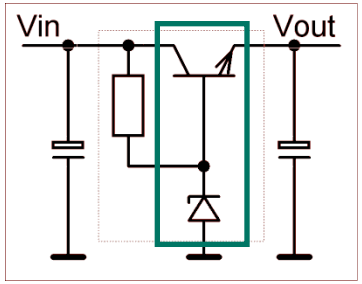
Note:
DC/DC is part of gate driver IC.
i.e. integrated together with gate driver in a single device
LDO's are not low drop, they are linear regulators made with discretes (low cost)

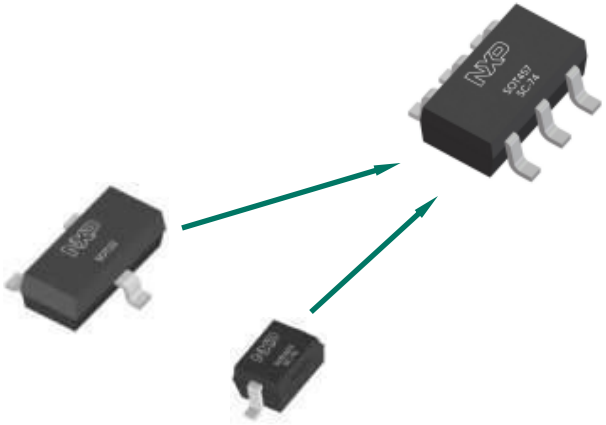
Self Powered Modules

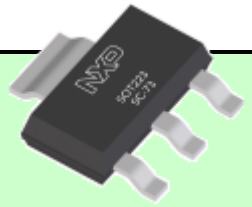
- High Efficiency DC/DC Step down
- LDO's for local regulation
- Advanced Power Down Capable

3.3V Voltage regulator – PVR100-series

- Combines general purpose transistor and Zener diode
- 100 mA output current – 5 output voltages
- 2 packages with different P_{tot} capability
- One external resistor sets the Zener current

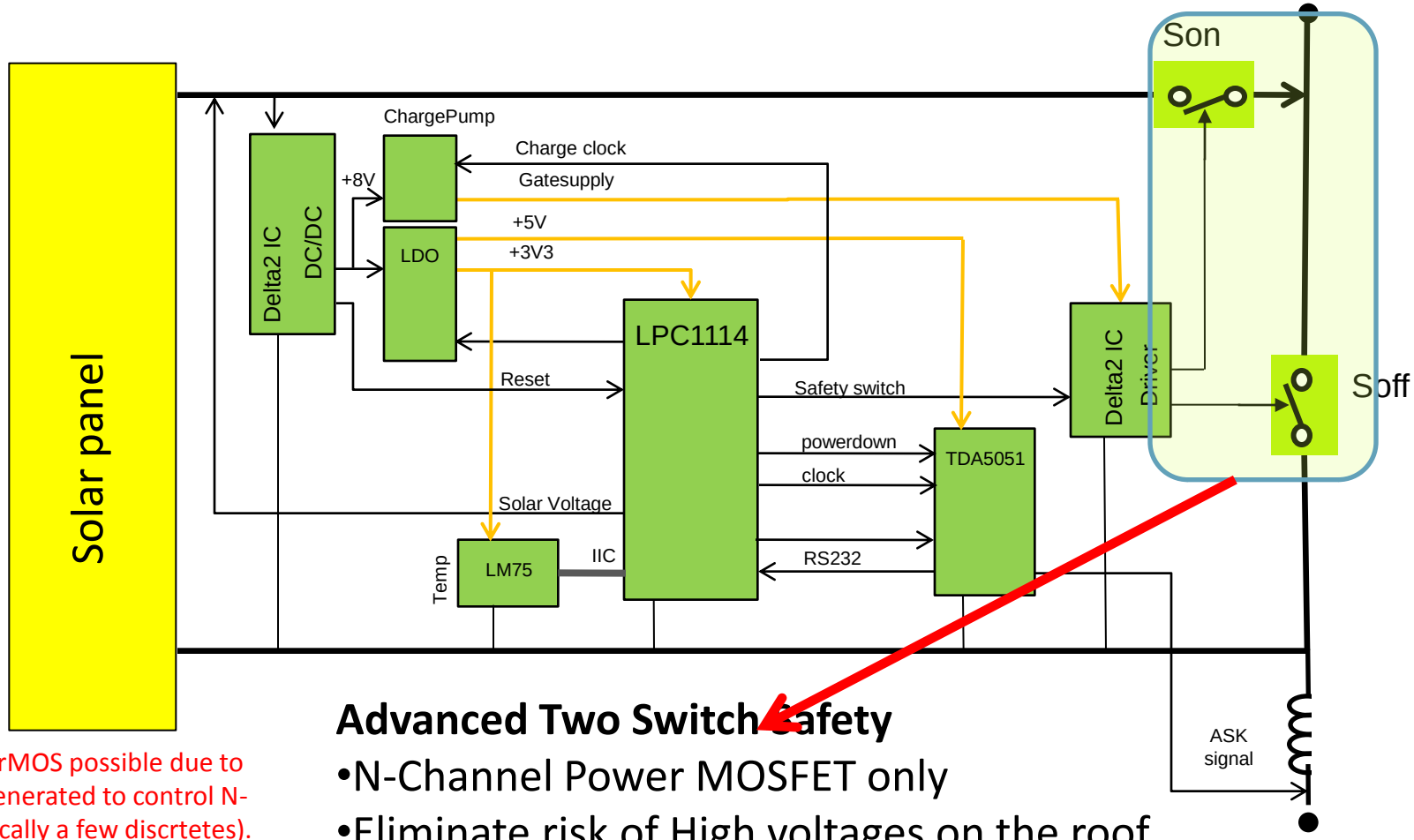




V_{CEO} = 40 V I_C = 0,1 A	 SOT223 (SC-63)	 SOT457 (SC-74)
↓ V_{out} P_{tot} →	1300 mW	700 mW
2,5 V	PVR100AZ-B2V5	PVR100AD-B2V5
3,0 V	PVR100AZ-B3V0	PVR100AD-B3V0
3,3 V	PVR100AZ-B3V3	PVR100AD-B3V3
5,0 V	PVR100AZ-B5V0	PVR100AD-B5V0
12 V	PVR100AZ-B12	PVR100AD-B12

In Production

Block Diagram – Solar Ref Design – Details(5)

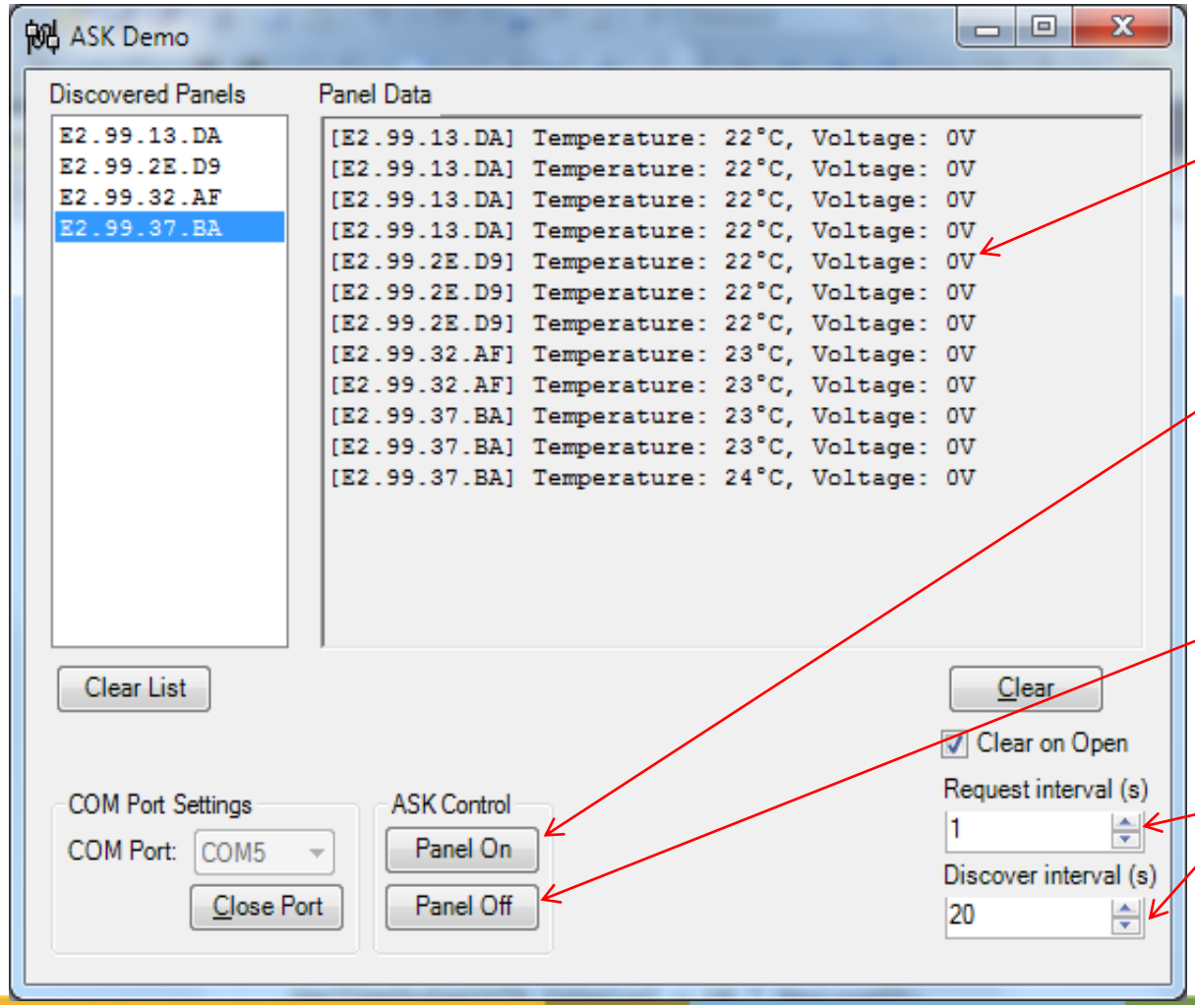


Note:
N-CH powerMOS possible due to HV signal generated to control N-CH fet (basically a few discrtetes). Can also use 1 N-CH and one P-CH mosfet.

Advanced Two Switch Safety

- N-Channel Power MOSFET only
- Eliminate risk of High voltages on the roof
- Maintain Local Panel Voltage in safety mode
  - Keep module alive

Solar Controller GUI



Monitoring temperature and output voltage

For **Normal mode --** switch the Connect button, LED is on

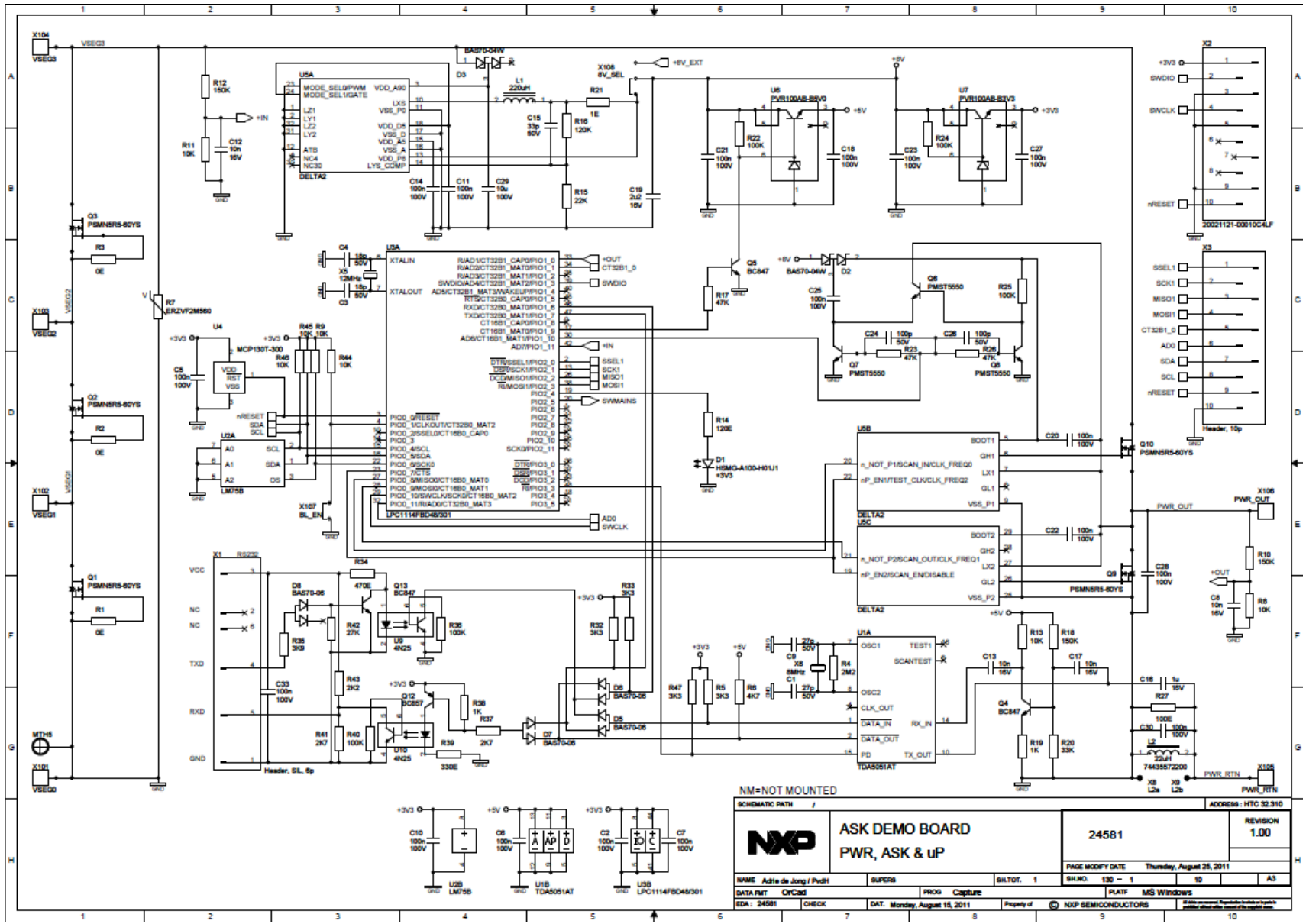
For **Safety mode --** switch the Short-circuit button, LED is off

Settings to reduce power consumption by setting the modem turn-on intervals between communication and panel discovery

Application Software - Features

- At the beginning:
  - the master does not know which slaves are connected.
  - At random interval (based on identification code of MCO) the slaves will broadcast a message and the master will recognize it and add the panel identification to the list of panels to be interrogated

- Normal operation
  - Master interrogate each individual panel in his list
  - Once the slave receive a poll messages addressed to himself, it will respond by sending the data back to the master (V, T, …)
  - If the master do not receive data back in xxs, it will try again and after xxs an error will be generate
  - To avoid cluttering of the network with unused slaves, any slave that does not respond to the message an “x” number of times, is removed from the list.
  - The slave is polled for data at a regular interval of time specified by the user and programmable via GUI
  - The master will perform basic CRC check on data received from slave



BOARD SCHEMATIC excl. AC/DC Conversion

NXP Support Tools for TDA5051A

- TDA5051A Power Line Modem datasheet ……..
- TDA5051A Product Brief ……
- UM10422 – TDA5051A Stand-alone demo board user manual
- TDA5051A Demo Board Kit OM13313 thru e-demoboards https://extranet.nxp.com/group/distinet/edemoboards
- TDA5051A Application and Software support
- TDA5051A Application Note AN10903 ……...
- TDA5051A Master/Slave Lighting Demo Kit OM1334 thru e-demoboards
- UM10495 – TDA5051A Master/Slave Lighting demo user manual
- PTM on Digikey Website. http://www.digikey.com/PTM/IndividualPTM.page?site=us&lang=en&ptm=25373

THANK YOU